Concrete

Vol. 25 *Detroit, July, 1924* *No. 1*

Pirates

SCIENCE and invention have gone along together in developing speedier and better methods of construction, but there is no opportunity for greater future improvement than in the development of the human instruments by which these methods are practiced.

In each department of effort the human factor is the sleeping giant. Engineering has always been a field of effort which has attracted men of fine mettle. It has not always produced men of the broadest view, nor has engineering work always been entrusted to skilled engineers, or to engineers at all. The construction field is full of "self-made men" of a rugged and often of a delightfully wholesome two-fisted type. On the other hand, the speculative elements of the game have lately attracted scheming shysters of the lowest order of civic conscience. They have no sense of responsibility other than to their bankers, and to "get by" is their complete decalogue of righteous conduct.

It is good to see the efforts of the Associated General Contractors to raise the standards of their business, and of the Philadelphia Building Congress to raise the standards of effort and pride in craft achievement all along the human line from the mechanic to the designer over all.

There is perhaps no great industry in more dire need of quickened conscience than the construction industry.

From a brief discussion of "Business and the College Man," by James Simpson, President of Marshall Field & Co., we get this sentence:

"The element of chance and speculation in business is yielding more and more to scientific organization and planning, and the acquisitive type of personal success is less highly regarded than that of achieving —creating—accomplishing something which will be a real contribution to society and to our fellow men."

It was written of the need for better trained and more cultured minds in mercantile pursuits, but is clearly and definitely applicable to many phases of the construction field, where honest men blush for the practices of competitors whose conscience and culture put them on a par with the river pirates of the Yangtze-kiang.

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Certificates of Quality

THE block manufacturer's "certificate of quality," once earned, is only as good as his ability and inclination to maintain the quality established.

Dishonestly used, a certificate of quality, however impressive its seal and its signatures, may do more harm than good.

Eternal vigilance is the price of quality, as it is of freedom. Freedom from the stimulating and corrective influence of constant inspection is a bad kind of freedom for any manufacturer to enjoy.

The Wisconsin Concrete Products Association now issues to its members who earn it, certificates of quality bearing the signature of W. C. Muehlstein, building engineer of the Wisconsin Industrial Commission. A certificate is good for a year at most, and is to be revoked at any time products fail to meet the tests of the Wisconsin building code.

The Wisconsin products men show a proper spirit. In no way can they bring lasting benefits to themselves so surely as by setting up a system of quality maintenance and enforcing it so regularly and rigorously as to make it a constant reflection upon the ability and good intentions of manufacturers who might choose to remain outside the organization.

This way is freedom from the worst type of competition—the competition of the producer who undersells by making inferior products.

Let the Wisconsin men go a step further—add to that certificate of quality blank spaces to be filled in, one every month at least, with a record of satisfactory test performance.

* * *

Science

THE keynote of Dr. William Lowe Bryan's baccalaureate address to 2000 students graduated the other day from the University of Michigan, was in his comment that men have succeeded marvelously, particularly in the last 100 years, in dealing with nature but have done very badly in dealing with human nature.

Science has harnessed thunder bolts and Niagaras; navigated beneath the sea and in the thin air above the Himalayas; it sends its messages, unattended, across a continent, but it hasn't completely solved the simple problem of peace and amity between the mechanic and his boss, between the salesman and the customer, between the dealer and the producer, between the people and their governing representatives, between the French and the Germans. In fact, Science has not mastered the problem by which a man must first of all be at peace with himself. Perhaps science never will. We can't leave everything to science. The men in any business are more important than their tools and their mental attitude is richer in possibilities than the most carefully drawn specifications.

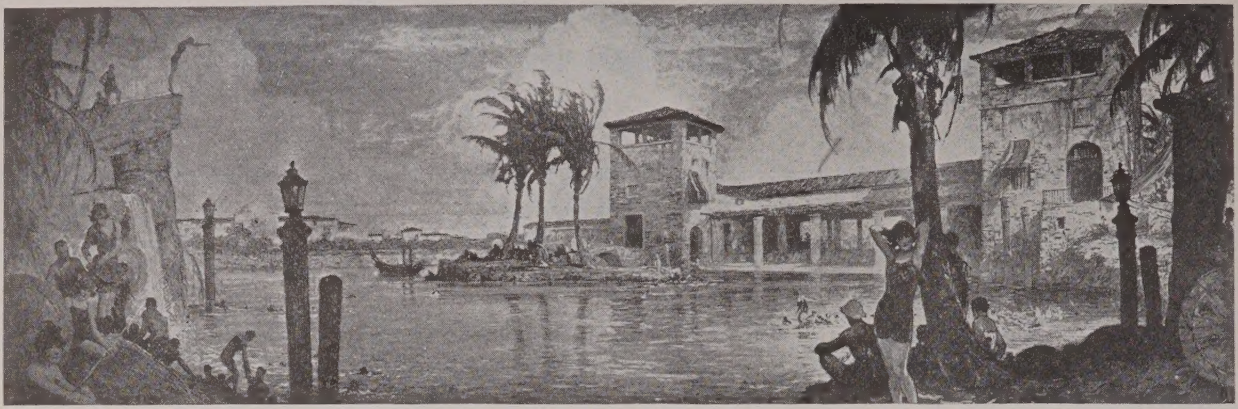

Fig. 1—From Artist Fink's Painting of Venetian Lake, as It Is to Look When Completed

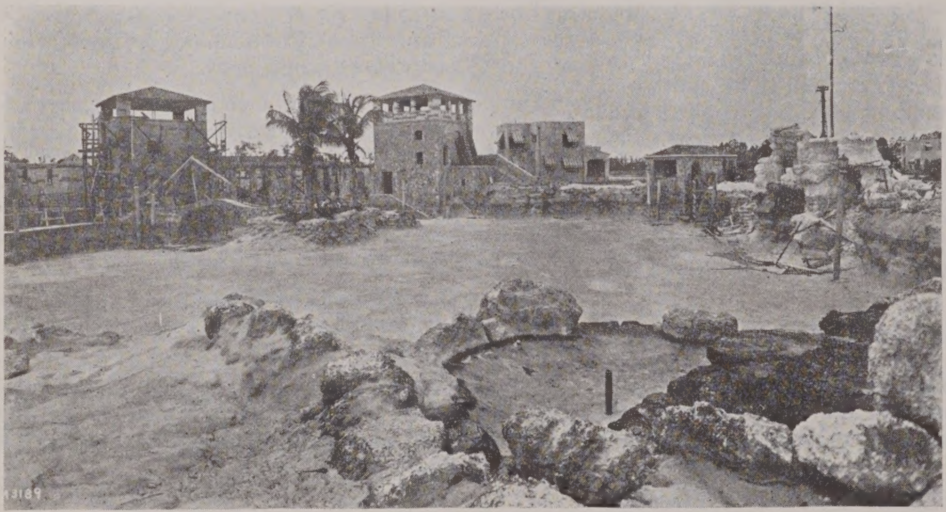

Fig 3 — After the Water was Drained Out for Final Construction Work

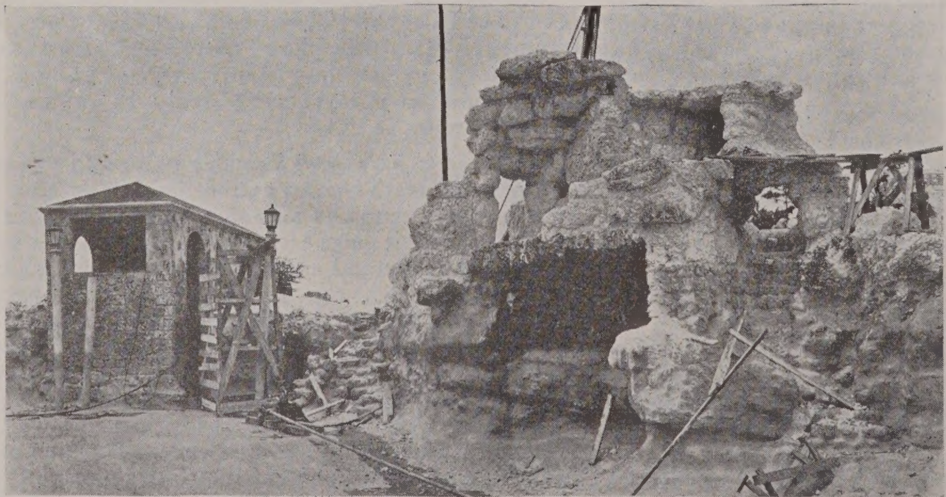

Fig. 4—The Diving Cliff in Course of Construction

Venetian Pool at Coral Gables

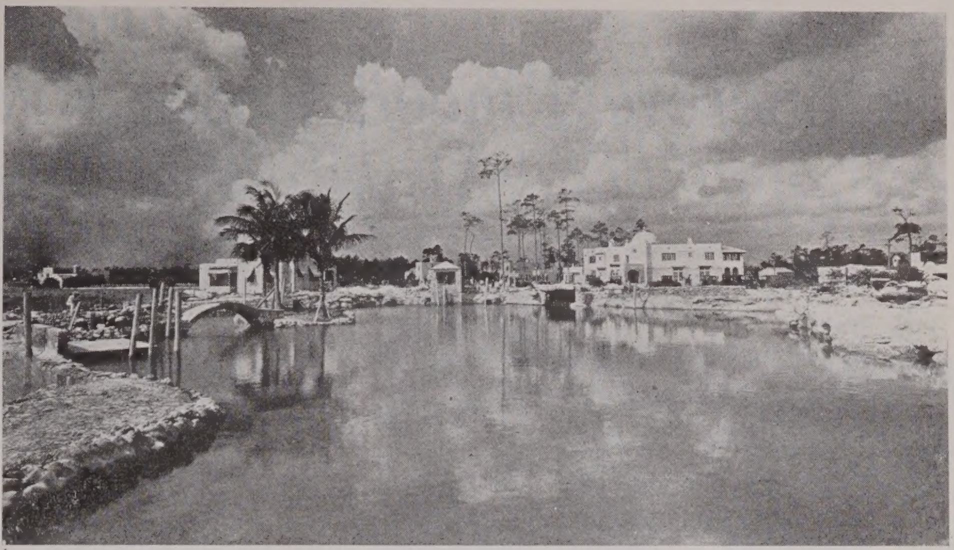

FIG. 2—VENETIAN LAKE IMMEDIATELY AFTER THE WATER WAS FIRST TURNED IN SEVERAL MONTHS AGO—BEFORE FINAL EMBELLISHMENTS WERE COMPLETED

Among the outstanding achievements accomplished by George E. Merrick, owner and developer of Coral Gables, a suburb 3 miles west of Miami, Florida, wherein concrete has played a leading role in the construction program,[1] is Venetian Lake—an outdoor swimming pool of irregular shape, approximately 200 ft. long and 100 ft. wide.

The pool is the creation of Denman Fink, a New York artist, who gained fame during the World War for his posters used in the Liberty Loan drives. When completed, the Venetian Lake will cost approximately $75,000. Nine months ago, the site of Venetian Lake was a huge rock quarry, and Mr. Merrick turned over to Mr. Fink the task of beautifying it in such a manner that it would not mar the beauty of the surrounding homes. The work of transforming it into a pool was immediately begun, the contract being awarded to Del Merrell, contractor of Coral Gables. The surface of the quarry was leveled off and a waterproof concrete bottom laid. At one side of the pool, a series of grottoes was cut from the coral rock walls, and so designed that when the pool is filled with water, swimmers can go through the narrow openings and there find sufficient headroom to stand erect or rest on the rock benches which have been provided just below the water level. The interior of the grottoes will be lighted with colored electric lights, and at night prove one of the most attractive spots of the huge basin. At one side of the main pool a smaller basin for children has been provided, with a real sand beach on which to play. Flowing water enters the pool over two cascades, one of which is exposed to view, with a drop of 4 ft., and the other partly hidden in a cave.

In the center of the pool is a small island, constructed of earth, coral rock, and concrete, on which four bearing cocoanut palms, each 25 ft. high, have been planted. An arch bridge connects it with the mainland.

With the completion of the grottoes and pool proper, the rough rock walls were covered with a cement coating and painted in a combination of blues and greens, which show through the clear waters and provide an effect similar to the hidden shoals of the Bahama Islands. The plumbing in the pool was handled by William E. O'Neil, contractor, of Miami; the painting, by the New York Decorating Co., of Coral Gables, under the supervision of W. Paist, color expert in charge of this class of work in the entire suburb. Water for the pool is provided by two pumps of 1500 gal. capacity, and 56 hours were required to bring the water level up to the prescribed height, ranging from 5 to 14 ft.

A pergola pavilion, with bath houses at either end, built of coral rock and colored stucco; concrete posts, on which specially designed Spanish lanterns rest, were sunk into the pool; and a rock and concrete diving cliff, 25 ft. high and directly over one of the falls, all add to the general effect.

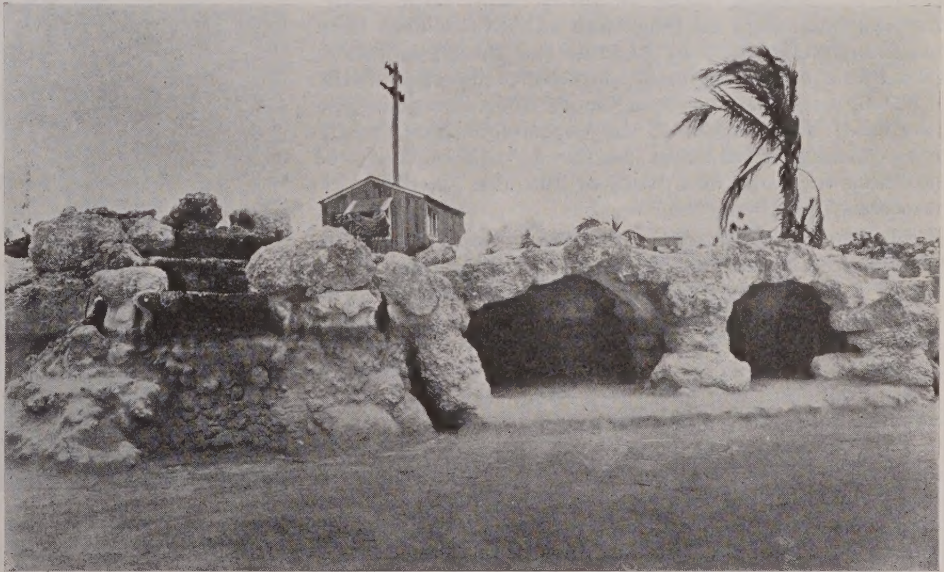

FIG. 5—GROTTOES AND ONE OF THE CASCADES AT LEFT

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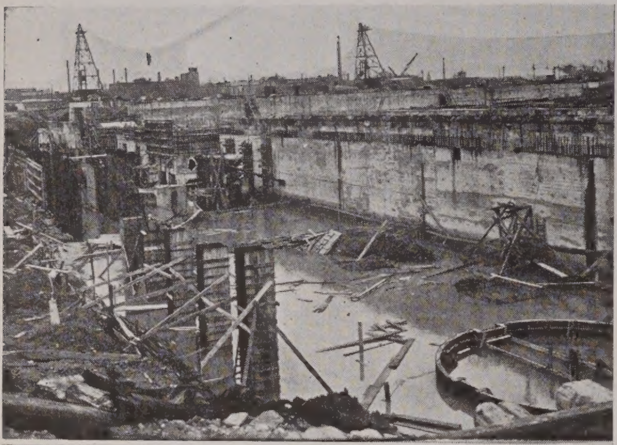
[1] See CONCRETE, Feb. 1924, p. 45.

Concrete Placed From Five-Ton Buckets



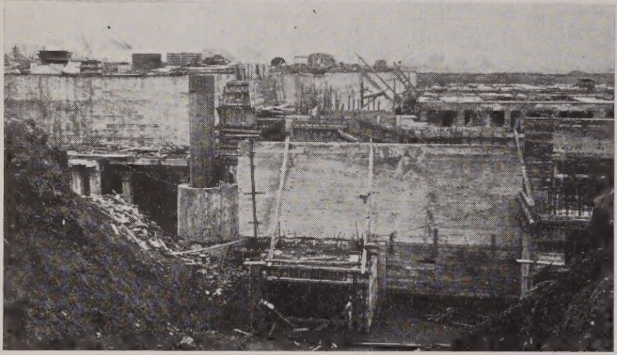


Fig. 1—General View of the Work on the New Filtration Plant at Buffalo, N. Y., from the Northwest Corner

Fig. 2—General View from the North End of the Work

When the new filtration plant now under construction in Buffalo is finished, in the fall of 1925, it will mark the successful completion of an unusual experiment in handling concrete on a very large scale. Five-yard buckets on long span cableways have been used with efficiency in placing the mixed concrete. For the concrete engineer, however, the end of the job will probably have no more than an academic interest. The success of the experiment has already been demonstrated, and as far as the methods of handling the large quantities of material go, the work is already finished.

The Buffalo filtration plant is being constructed on lines of the most modern filtration plant practice, it being of heavily reinforced concrete throughout. The total cost of the work is over $4,000,000, and it was started in 1922, to be finished next year. In the construction of the plant, a total of more than 55,000 cu. yds. of concrete will have been used. Some 40,000 cu. yds. of this total is now in place.

This represents an immense quantity of concrete, and added to the ordinary difficulties of handling so large a mass of material as in this case, there is the condition that practically all the work on the plant has to be done below the ordinary ground level.

It was decided that the cable railway system offered the best method of placing the material, and tracks were built along the east and west sides of the job, along which four movable towers, operating cable railways, were set. All this was standard practice, but the towers themselves were unusual. They were constructed especially for the job, of steel girders reaching 85 ft. above their bases. They have a lifting capacity of 18 tons.

The unusual height and the great lifting capacity were required because of the fact that the span between the towers, over which the cable railway runs, is 800 ft., and buckets of concrete they carry over this great distance weigh approximately 12 tons each. The concrete, in opposition to the usual practice of delivering it to the job in 1-yd. buckets, is being handled in special buckets of 5-yd. capacity. It can be readily seen that to handle 12-ton buckets over an 800 ft. span requires something out of the ordinary in cableways.

The concrete is mixed for the job in a special mixing plant, consisting of a temporary building at the north of the job, and placed conveniently where it can receive both from the railroad and from barges. It is about 50 ft. high, and approximately 28 ft. by 52 ft. at the base. At its top are two storage bins of about 300 cu. yds. working capacity, and on the second floor, two 1½-yd. capacity motor driven concrete mixers and a discharge hopper. The ground floor is occupied by a narrow gauge railway track used for transporting concrete to the work. A motor-driven elevator lifts the materials from the ground up to the third floor.

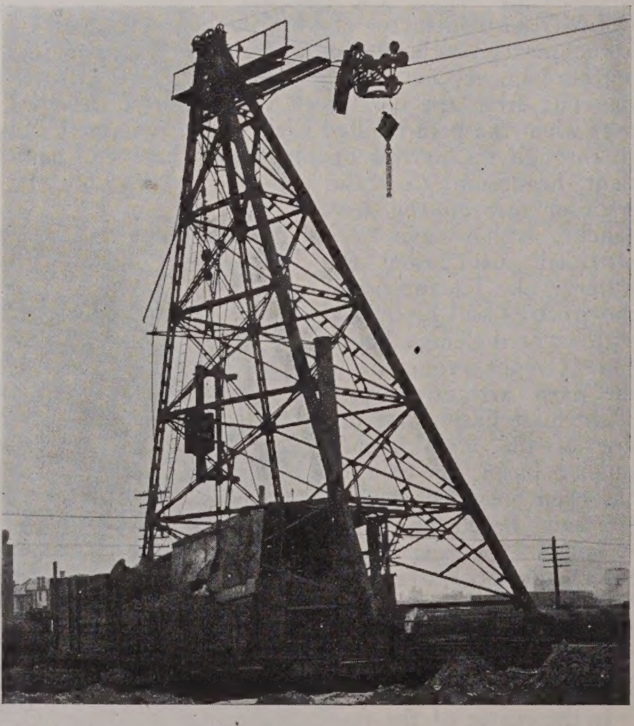


Fig. 3—One of the Towers Supporting the Cableway in Use in Construction of New Filtration Plant. There are Four of These Towers, Each 85 ft. High, Specially Constructed of Steel for This Job. The Towers Have a Lifting Capacity of 18 Tons

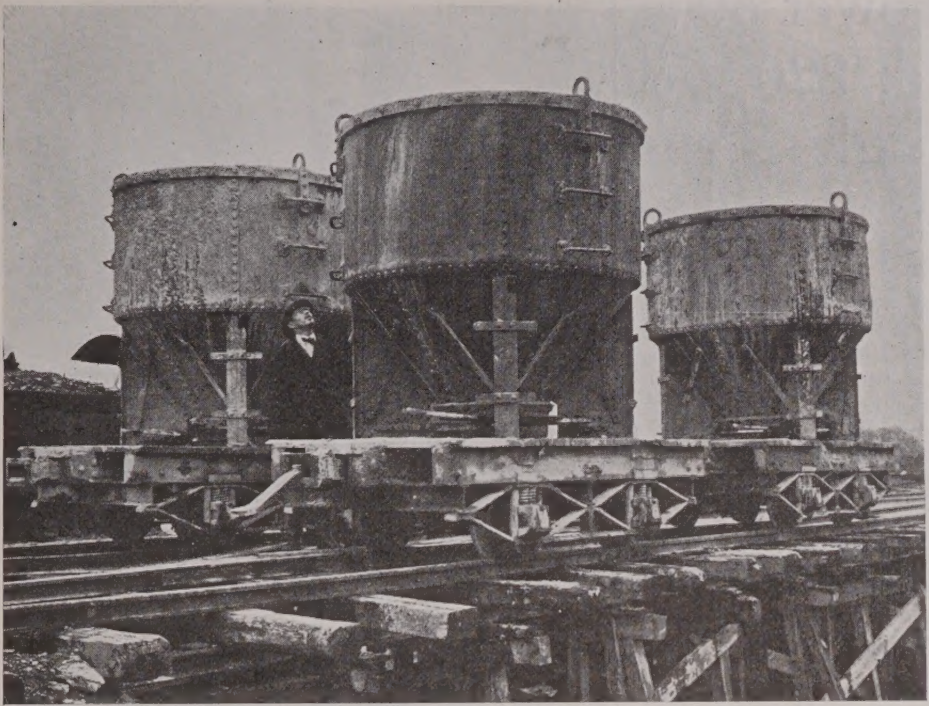


FIG. 4—THE 5-CU. YD. CONCRETE TRANSPORTING BUCKETS BEING USED ON THE NEW FILTRATION PLANT UNDER CONSTRUCTION IN BUFFALO, N. Y. THE CONCRETE IS MIXED IN A SPECIAL TEMPORARY BUILDING AND DISTRIBUTED OVER THE JOB BY MEANS OF THESE BUCKETS RUNNING ON A CABLEWAY. BUCKETS AND CONTENTS WEIGH APPROXIMATELY 12 TONS

The mixers on the second floor of the concrete mixing plant discharge into the discharge hopper, which in turn discharges into the 5-yd. transporting buckets. This arrangement was adopted in order that the mixers might be kept in constant operation, and that the concrete might arrive at the job at a uniform rate. It has been found that this arrangement also makes for speed.

The narrow gauge railway carrying the concrete from the mixing plant to the job was specially built for the work, and cars are operated by gasoline locomotives.

There has been but little difficulty encountered in handling concrete in the unusually large and heavy buckets used on this job. The chief objection to them, according to the engineers on the work, lies in the carelessness of the workmen, who are apt to allow them to fall against the forms in discharging, and the heavy buckets with their heavy load of concrete naturally tear the wooden form to pieces when they come in contact. But this is an objection depending upon the personal factor, and it can be eliminated. From an engineering standpoint, the possibility of handling concrete in large quantities over long distances by means of the heavy buckets and cableways has been successfully demonstrated.

Niagara River gravel is used without screening in the concrete for the job. After trying a great many locations in the river, certain ones were found which gave a material meeting the specifications. Gravel is pumped into barges from these, and the barges towed to the mixing plant at the dock. It is unloaded from the barges by crane, and carried to the storage hoppers in the mixing building by means of a bucket conveyor.

The gravel is sampled in the barges as they are being loaded, and the samples immediately tested for fineness and weight. They must meet a specification of a fineness modulus of not less than 5.5 and a weight, loose and dry, of not less than 120 lb. per cu. ft. If the samples prove unsatisfactory for the work, the gravel company is immediately notified, and the barge diverted to some other point and the material disposed of elsewhere.

The maximum daily run of concrete is 762 cu. yds. The concrete is of a uniform mixture, running five of gravel to one of cement, and is of almost exactly the same consistency as that used in jobs where the concrete is placed by means of chutes.

The proposition of handling the small flat-cars that transport the buckets, in train was considered but it was felt that this would require a heavier gasoline engine and more buckets, while the mixing plant is at present kept busy supplying the three buckets now in use. Each bucket is handled on a separate flat-car, as the weight of 12 tons is considerable. The flanges on the buckets, as shown in Fig. 4, keep the bucket upright on the car.

Unde the car and cableway arrangement, the work of transporting concrete goes forward with considerable speed. The average time spent in placing the concrete on the job, from the moment the mixers discharge into the hopper until the buckets are discharged into the forms, is between five and ten minutes, and rather near the lower figure. The engineers in charge state that a delay of as much as half an hour would hardly be serious, in view of the very large quantities of concrete handled at a time.

Loops at three points on the buckets are the means by which they are lifted. These loops are seized by hooks at the end of chains on the car on the cableway shown in Fig. 3. The buckets are discharged by means of a gate at the bottom, operated on the job.

The contract is being carried out by the Thompson Starrett Co., New York City.

Index to CONCRETE, Vol. 24, January to June, 1924, is ready and will be sent to all subscribers who ask for it.

Concrete Tower 50 Years Old, 220 Feet High

By H. C. Badder

London, England

During the period from 1865 to 1875 great interest was taken in portland cement and concrete by the general public in England; yet at the Great Exhibitions in Hyde Park in 1851 and 1861, the public had taken little notice or interest in the cement and concrete exhibits, some of which weighed over a ton.

This sudden interest can be ascribed to several causes; Mr. Tall, the French Exposition, and the Emperor Napoleon may be cited.

It was Mr. Joseph Tall who first invented portable climbing forms for concrete work, and as often is the case with inventors, he claimed such immense saving over the cost of brick and stone walls that people became interested in his methods, and many builders bought his apparatus and paid Mr. Tall a royalty upon each house built.

A company was formed to exploit and build with his apparatus. Mr. Tall supervized the building of several cottages with his forms at the French Exposition, and the Emperor presented him with a medal.

Few of the builders who adopted these concrete forms had much technical knowledge of concrete, so many accidents occurred. A boundary wall of great length was so rapidly erected, about 6 ft. high of 6-in. plain concrete, at Teddington, near London, that it blew down during a wind storm before completion.

In another accident, a concrete house, four stories high, being erected in 1868 at Twickenham, a village just a short distance from Teddington, fell down, and the remaining part had to be taken down.

During 1872, a concrete building near Islington Green, London, in course of erection, collapsed, killing one man and injuring others; and in 1876 a jury gave a verdict of manslaughter against a builder, named Blanford, for erecting a concrete house which fell down and caused the death of a child, the concrete being described as of the worst possible quality.

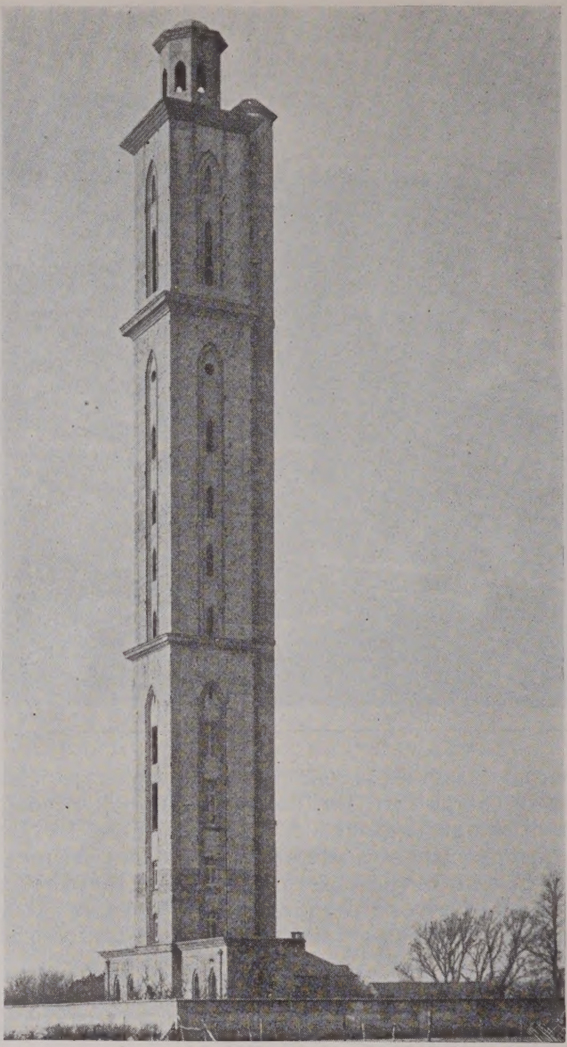
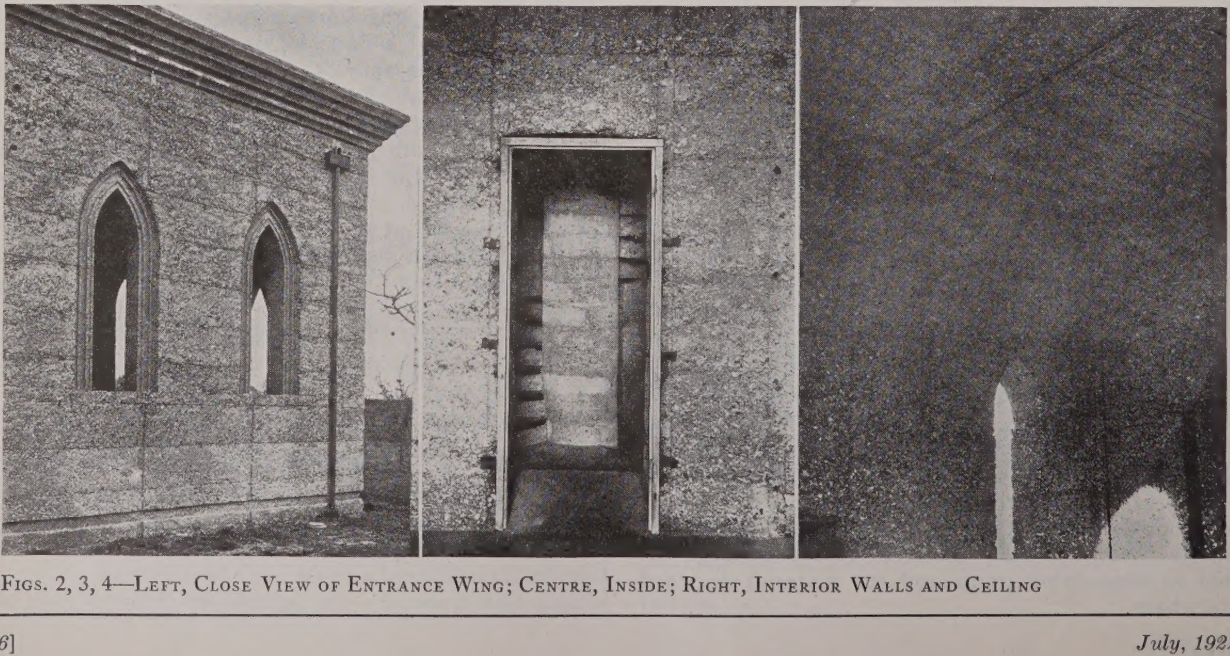
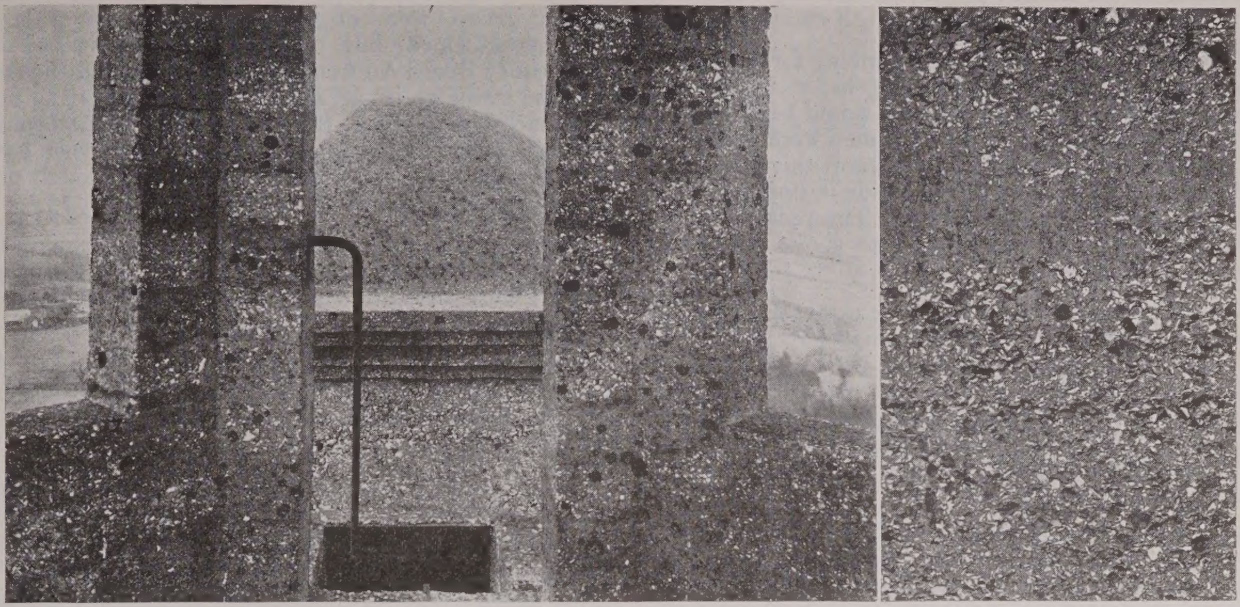


Fig. 1—Tower 22 Ft. Square, 220 Ft. High, Built of Concrete 50 Years Ago

These accidents may also have provided one of the causes of public interest, roused by the newspapers and the architectural journals, which discussed them



Figs. 2, 3, 4—Left, Close View of Entrance Wing; Centre, Inside; Right, Interior Walls and Ceiling



Figs. 5 and 6—Left, Surface in Observatory; Right, Close-up of Concrete Surface

at length and carried on a correspondence for and against the use of concrete for any purpose except foundations or stucco over brick walls.

It was in this period that A. T. T. Peterson, a lawyer by profession, many years leader of the Calcutta Bar and also a Judge of the High Court of Calcutta, India, retired from practice, realized his investments and returned to England to settle down at Sway, a small village in Hampshire about 12 miles west of Southampton. Here he bought an estate and made investments which, no doubt, included some shares in The Isle of Wight Portland Cement Co., Ltd., which erected works at Newport, about fifteen miles from Sway.

This would account for his interest in portland cement and concrete work, with which he made a large number of experiments, that culminated in the construction of farm buildings, boundary walls, and a wonderful concrete tower about 220 ft. high, which he designed, being his own architect and builder, the whole of the work being carried out by local rural labor during a period of three years.

The illustration (Fig. 1) from a photograph made on January 7, 1924, 50 years after completion, shows the high slender shaft, only 22 ft. square at the base, and practically without any supports. Note the fine vertical lines of the concrete, composed of 5 parts of fairly well-graded gravel, 1 part of sand to 1 part of portland cement, which produced a surface that would provide a good key for a rendering coat, which was intended but never applied.

The design is based upon classical lines with semi-Gothic details, and the main intention was to show what could be done with concrete carefully made, deposited, and cured. It is monolithic, except for the spiral steps in the hexagonal projection, the molded courses to window openings, and cornices, which were cast in molds and tinted with oxide of iron.

The wall in front of this view of the tower is also of monolithic concrete with a cast flat coping.

The interesting feature is the relation of small plan dimensions to great height. It is exposed to all the winds that blow, and is near the sea coast. It may have some protection by the Isle of Wight from the southeast, but little or none from other directions.

The excavation for the foundation was 9 ft. below ground level, and the concrete footings to the walls were deposited 4 ft. 6 in. wide and 3 ft. 6 in. thick; but a large concrete vault was formed between the footings up to the ground floor level.

The double projection east and west of the tower are entrances, and the footings to the walls are similar to those for the main tower. The ground floor walls are 2 ft. thick, making the room inside 18 ft. square. At a height of 98 ft., a molded course of pre-cast concrete is built in, and the walls reduced from the outside to 18 in. thick, the size of the room being kept the same. Again at 108 ft. is a second molded course, and the concrete being offset to 14 in.

The walls of the octagonal observatory above the main cornice are 9 in. thick, also above the main cornice is the dome-shaped top of the hexagonal staircase, inscribed in a 9-ft. circle containing 330 pre-cast steps. There are other steps of iron from the cornice level into the observatory.

The climbing timber shuttering or forms were made 18 in. deep, and three heights were used; studding was used as spacers inside and outside the walls, and the forms were bolted to these right around the tower. One course of form was filled with concrete, then the second and third; when the third form was filled, the lowest was removed to the top for concrete filling. Thus there was always 3 ft. of concrete held in the forms while the third was being filled and rammed with the concrete of a consistency used in those earlier days of dry mixes for tamping.

At openings, wood frames were inserted between the forms, and it will be noticed from the illustrations that it was possible to insert the pre-cast concrete reveal moldings between the forms, so that they could be tied into the walls, because they do not project beyond the face on the exterior or interior of the wall.

The eleven floors in the tower were constructed of rolled iron joists, the ends of which were concreted into the main walls; wood forms were fixed level with the bottom of the joist flanges and concrete deposited between them, the top surface being finished smooth.

The concrete was mixed upon a boarded floor to an even color dry, and then damped with water from a watering-can, with a perforated spout or outlet, while being turned. It was then filled into a hopper and hoisted by means of a windlass at first and at greater heights by means of blocks and pulleys, with a steady old horse as the motive power; an opening was left in each floor for hoisting materials until completion.

It took two days to raise the climbing form, and two days to fill and ram the concrete, hence the average quantity of the concrete deposited would be about four cubic yards per day. A number of men were constantly filling molds for pre-cast concrete, and this was mixed 1:2:4, with a proportion of iron oxide in fine powder to make a smooth finished surface. The red tint of the colored concrete is very good, and shows practically no sign of fading.

Gravel and sand found upon the estate were used in the foundations, except for one small part, which will be noticed as a darker band by the third floor windows. This was caused by a delay in the carts arriving from Milford-on-Sea, where the aggregates were gathered; as the whole of this material was washed before use, it was probably thought all washed aggregate would make concrete of the same tint.

Fig. 2 shows a close view of one of the entrance wings, the marks showing the line of the studs used to carry the climbing shuttering are plainly visible; if the walls had been plastered, these would, of course, have been hidden. The sharpness of the angles of the concrete are worthy of notice after fifty years' exposure. The roofs over these wings are also of 1:2:4 mix concrete, with a 6-in. crown in the middle to throw the water to outlets at the walls. After the concrete was cured and dry, it was coated with ordinary coal tar, and has not been touched since; this coating has worn off the roof, but part of it can be seen in the gutters, and the roof is perfectly watertight now.

Fig. 3 is a view inside one of the rooms, and not only shows the quality of the concrete walls and stud grooves, but also the concrete column carrying the pre-cast steps. Part of a floor is also seen, and the rectangular hole through the wall, of which there were twelve at each floor level, held the joists which carried the outside scaffold that was 6 ft. wide. The joists were brought to the center of the floor and clamped together.

Fig. 4 shows another room and the rolled iron joists carrying the floor above. These are in perfect condition where exposed. Fig. 5 is taken in the octagon observatory above the main cornice. The large dark spots are growing lichen, the spores of which have either been blown there or accidentally carried there by the many birds that fly in and out of this portion of the tower.

From this point a magnificent panoramic view is obtained of the surrounding country for many miles. Facing the visitor are the famous Needle Rocks, standing out boldly; while slightly to the left are the high cliffs at Alum Bay, with their wonderful and variegated colors. Picturesque Totland Bay is also noticeable; and Hurst Castle, the guardian of the narrow channel between the mainland and the western extremity of the Isle of Wight, wherein the unfortunate monarch, Charles I, was in 1648 kept in close custody for a month and three days, and where the town chest of Lyminton was deposited, while Prince Rupert's fleet lay in the Solent, is a prominent view presented to the onlooker.

On a clear day, far away in the east, may be discerned Portsdown Hill, crowned by the fortifications that guard Portsmouth and Spithead. On the west, Christchurch Priory Church is plainly visible, and Swanage in the distance forms a boundary to the vision. It is also stated that the spire of Salisbury Cathedral is to be seen.

The circular openings at the top of the second Gothic recess were originally intended for a large illuminated clock, but this proposal was vetoed by the Trinity Board Authorities, who control lighthouses, because owing to its great height, it is one of the first landmarks that meet the eye of the home-coming mariner from the English Channel. No bells have been hung, nor has a flagstaff been fixed, though preparations were made.

For years the tower stood defying the storms, without even a lightning rod, but it was struck a few years ago without any great damage, and a lightning conductor has since been fixed for protection.

Fig. 6 is a close up view of the concrete face on the north and worst weather side of the tower. Considering the concrete proportions were 1:1:5, old Time has not had much effect upon it.

Mr. Peterson died, a nonagenarian, some few years ago; what his real intentions regarding the tower were is not now clearly known. No doubt the cost was heavy, in spite of the low wages paid at that time. The builder, in altruistic sympathy, made employment for the village carpenters, smiths, and laborers, as the work was done when unemployment was very prevalent. Why the original design was never completed cannot be fathomed now. As it stands, some use may be made of it by the Government authorities on occasion. At one time, visitors were allowed to inspect the tower and see the view from the top, but this was stopped some years ago.

There the tower stands, practically as perfect as it was 50 years ago, human neglect does not affect it; no painting is required to preserve it; the rolled iron joists have been preserved by the concrete and are perfectly sound. Now that it is protected from lightning there is no visible reason why it should not stand for another 50 or even 100 years.

The walls are of plain concrete, the only ties into them are the iron joists at the floor levels, and these are not anchored by bolts or rods, yet the perpendiculars are as plumb as when built and as true as men could make them.

Concrete Ties

The Connecticut State Highway Department has been making use of reinforced concrete ties of a special notched design, in lengths, 5 ft., 6 ft., or 7 ft., and 6 in. x 8 in. in section, in the construction of cribbing to hold steep embankments where space restrictions prevent the necessary slope for dirt fills. Pictures of such cribbing are shown in the June issue of *Concrete Highway Magazine*, of the Portland Cement Association.

CONCRETE is interested in information as to concrete construction more than half a century old. With what old noteworthy work have you knowledge?

Special Features in Construction of New Pier

By C. R. Wilson

General Manager Atlanta Office, Turner Construction Co.

Reprinted from the April-May, 1924, issue of *Turner Constructor* published by the Turner Construction Co., New York City.

The construction of a new pier and headhouse for the Port of Havana Docks Co., in the harbor of Havana, Cuba, presented many interesting problems in design and construction methods.

The work consisted of building a reinforced concrete pier and headhouse adjacent to the other docks of the Port of Havana Docks Co., in Havana Harbor. The work was done under the supervision of the Parklap Construction Corp., of New York, who acted as engineers for the owners. Two principal contracts were let in connection with this contract, one to the Raymond Concrete Pile Co., for the making and driving of precast concrete piles, upon which the pier proper and a part of the headhouse were carried, and the other to the Turner Construction Co. for the erection of the concrete superstructure on these foundations. The engineers handled with their own forces all the finishing details of the work.

The pier deck was about 214 ft. wide, by a length of 626 ft. on one side and 582 ft. on the other. Along the length of this deck was constructed a two-story reinforced concrete pier 154 ft. wide and running to within about 20 ft. of the outboard end. This pier projected at an angle from the shore. The headhouse adjoining the pier ran parallel to the shore for a length of 447 ft., and varied in width from 63 ft. to 70 ft. Part of this headhouse was three stories, and part was four stories in height, and about at its middle point it was surmounted by a massive and ornamental tower housing the sprinkler tanks. The whole job was of massive construction made necessary by the hard usage to which such structures are subjected. The main deck of the pier was designed for a live load of 250 lb. per sq. ft., the second floor for 400 lb. per sq. ft., and the various floors of the headhouse from 75 lb. in the office space to 400 lb. in those portions devoted to storage of merchandise.

One end of the headhouse projected out beyond the bulkhead line, and this portion of the headhouse and all of the pier proper were supported by heavy precast reinforced concrete piles. The other portion of the headhouse was supported on hardwood piles. The reinforced concrete piles were of heavy design, and were precast in an especially laid-out yard across the harbor from Havana. These piles varied from 50 ft. to 85 ft. in length, and weighed up to 20 tons each. The piles were driven in groups, each group being capped with a massive foundation of reinforced concrete, which carried the pier columns and the main deck of the pier. This deck was of a heavy slab construction, reinforced in one direction and varying in thickness from 8 in. to 18 in. The second floor of the pier and all the floors of the headhouse were of typical beam and girder construction. The roof of the pier was of metal lath and plaster construction carried on light structural steel framing. All columns were of concrete, reinforced with structural steel shapes, generally in the form of four angles latticed together with flat bars.

About 20,000 yds. of concrete had to be handled on this work, and the conditions met with were unusual. All of the pier proper was built over deep water, with large units of concrete to be placed in isolated pile caps. This condition made scaffolding between piers difficult, and enhanced the value of chuting equipment, if this could be arranged to move along with the structure, as it was built from the shore end outward.

After a careful study of the requirements of the superstructure of the pier as to placing concrete, it was finally decided to build a traveling carriage of sufficient size and stability to carry a complete 1-yd. mixing and hoisting plant, with motor drives, storage bin for materials and 100 ft. Insley steel tower with a 50-ft. counterweight boom and sliding frame attachments.

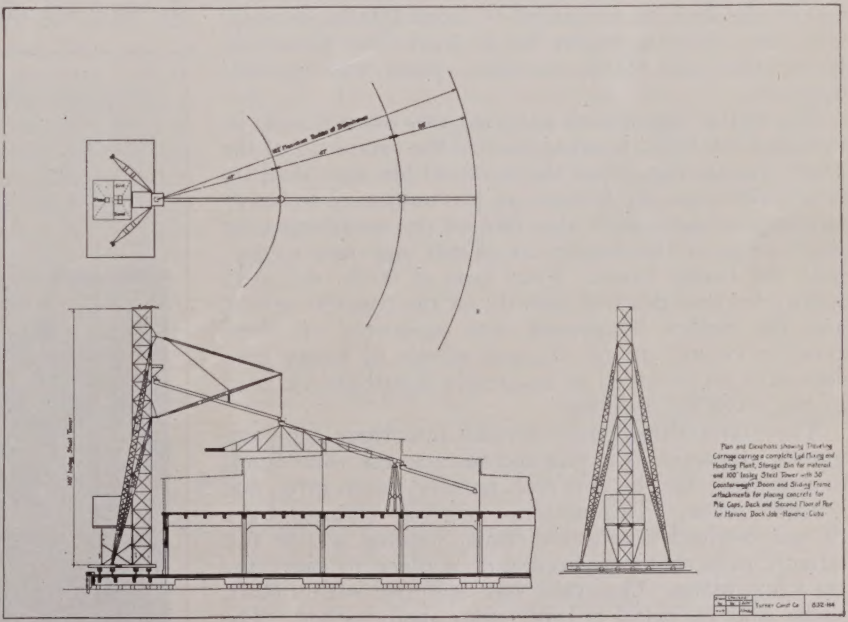

Plan and Elevations showing Traveling Carriage carrying a complete 1yd Mixing and Hoisting Plant, Storage Bin for material and 100' Insley Steel Tower with 50' Counterweight Boom and Sliding Frame attachments for placing concrete for Pile Caps, Deck and Second Floor of Pier for Havana Dock Job - Havana - Cuba
Turner Const Co
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Fig. 1—General Layout—Plan and Elevations Showing Traveling Carriage Carrying a Complete 1-yd. Mixing and Hoisting Plant, Storage Bin for Material and 100-ft. Insley Steel Tower with 50-ft. Counterweight Boom and Sliding Frame Attachments for Placing Concrete for Pile Caps, Deck and Second Foor of Pier for Havana Dock Job, Havana, Cuba

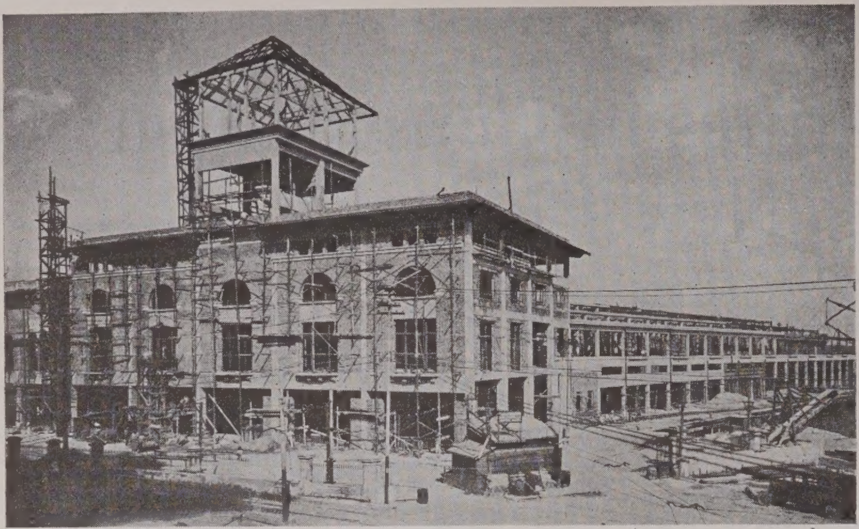

FIG. 2—HEAD HOUSE—LOOKING AT WEST FRONT OF HEAD HOUSE AND SOUTHERLY SIDE OF PIER

This chuting equipment was designed with sufficient radius of action to place all concrete for the pile caps, deck and second floor.

There was only a small yardage involved in fireproofing the structural steel roof framing and columns, and it was decided to wheel this material rather than increase the height of the chuting plant. It will be seen from the illustrations that it was not practical to use guy lines on this tower, due to its mobility and the inability to obtain anchorage for guy lines on the water side of the pier, and it was therefore important to limit, as far as possible, the height of this Insley tower. It was decided to handle all of the concrete in the headhouse with a standard set-up of a ¾-yd. mixer and hoist, the concrete to be wheeled into place.

The deck projecting on each side of the pier house, or aprons, as these portions of the deck were called, were heavily designed to carry the weight of a double track belt line railroad, and it was decided to use the southerly one of these aprons as a supporting platform for the traveling concrete plant. For this reason, the southerly apron was always concreted ahead of the rest of the deck to an extent of about 100 ft., in order that this concrete might be at least four weeks old before the load of the traveling plant was imposed upon it.

The timber framework carrying this plant had to be very heavily built, because besides the total load of the plant, amounting, when the material bin was filled, to nearly 200 tons, the framework was subjected to heavy twisting stresses, as it also formed the anchorages for the bottom of the double set of stiff legs used to support the Insley tower. Four lines of 60-lb. rail were spiked to cross ties laid directly on the concrete apron, and the timber framework was supported on these rails by twenty double flanged wheels of heavy construction, so arranged as to equally distribute the load of the traveling platform.

The material bins were divided into three compartments, inasmuch as it was necessary to use three kinds of aggregate for the concrete, namely, sand, grits, and crushed stone. This material bin was charged by a 25-ton, 8-wheel locomotive crane, running on the two outside rails that had been put in place to carry the traveling plant. The crane was equipped with a 60-ft. boom and operated a 1-yd. clam shell bucket. The materials in this bin were fed by gravity through stone gates to the charging hopper of the mixer. In order to prevent the clogging of the gates by boulders or by large pieces of coral, which is often found in the sand used in Havana, a gridiron of 2-in. x 8-in. timbers on edge was placed over the entire top of the bin, and besides acting as a screen, it gave the workmen in charge of the unloading of the clamshell, a working platform.

Four especially made stiff legs were constructed of light steel members to support the Insley tower. Two of these legs went to the same anchorage on each side of the traveling frame. These stiff legs were approximately 87 ft. and 52 ft. in length, so that the Insley tower, as will be seen from the illustrations, was supported near its top and about its middle point. All of these stiff legs ran to special anchor plates on the front of the tower. All of the machinery operating this plant was electrically driven by 3-phase, 60-cycle, 220-volt motors. A 50-h.p. motor was directly connected by spur gears to a double drum hoist, which operated the concrete bucket and the sliding frame equipment. A 25-h.p. motor operated the 1-yd. mixer. The bucket was elevated at a speed of 150 ft. per min.

As this plant moved out with the work, the rails were taken up back of it and put down ahead of it so that not more than 100 ft. of track was neces-

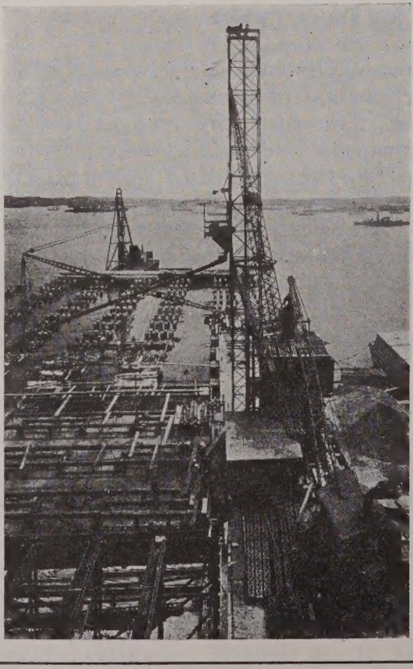

FIG. 3—GENERAL VIEW OF PLANT SHOWING LOCOMOTIVE CRANE UNLOADING BARGE OF SAND. RAYMOND FLOATING PILE DRIVER IN THE DISTANCE

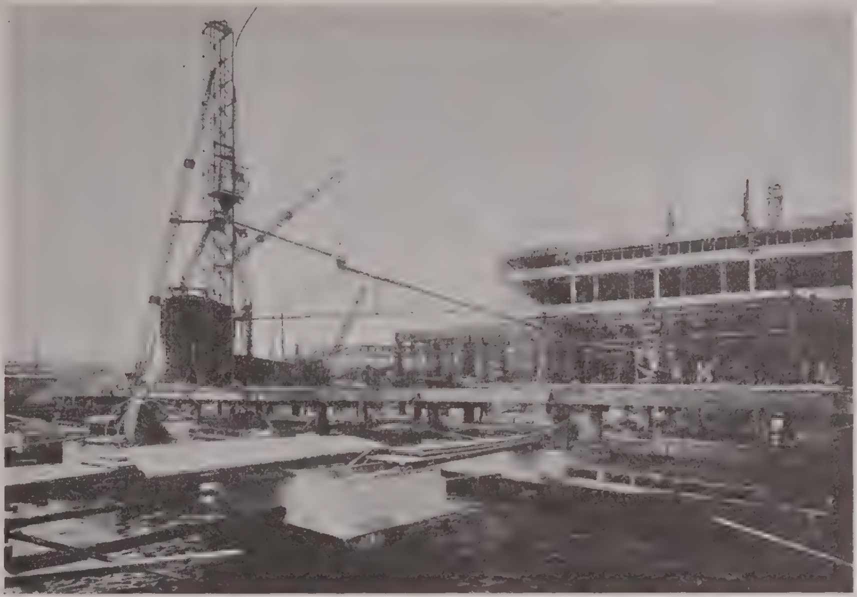

Fig. 4—Trusses and Hung Forms with Concrete Pile Cap in Center Foreground

sary. A 2-in. water supply line was laid as the work progressed, and a flexible hose connection was taken from this supply line to the water tank above the mixer. A power line was laid from the shore end out, and outlets were left about every 50 ft., so that as the plant moved, the flexible connection to the switchboard in the motor house could be inserted in a convenient outlet.

When this plant was decided upon, it was anticipated that it would only be moved about every 50 ft. to 75 ft., but in practice it was found so easy to shift the plant that it was moved back and forth at will, for even a small yardage of concrete. Provisions were made for anchoring the timber platform to the concrete deck as soon as the plant was in a position where concreting was to be done. The stability of this plant, especially when the material bins were full, was ample to withstand the overturning moment due to the heavy counterweight boom and chutes when full of concrete, but Havana Harbor is often subjected to cyclones of great intensity, and it was a rule that the plant was only to be moved when the weather was clear, and as soon as it was in position it was to be anchored down.

Special consideration had to be given to the construction of the form work for the main dock of this job. The heavy concrete slab was supported on the pile caps spaced 20 ft. on centers longitudinally with the pier and 30 ft. on centers transversely with the pier. This work was all done over deep water, so the pile caps were the only points of support for this form work. It was essential that the forms be taken down without sending any laborers underneath the pier, inasmuch as there was a clearance of only 18 in. between the bottom of the concrete deck and the water at mean tide, and much of the form work projected down into the water. It was necessary, therefore, to design a system of form work which would be entirely supported from above and which, when the concrete had sufficiently set to permit the removal of this form work, could be dropped by workmen from above the pier.

The initial support for the form work was in the nature of four 6-in. x 12-in. timber posts, resting on the corners of the concrete pile caps. Across the heads of each set of two posts, and resting on shoulders cut into them, were beams constructed of two 9-in. channels. These structural steel caps projected out beyond the 6-in x 12-in. supports, so as to give a bearing for the main timber trusses at a point in line with the edge of the pile caps. The ends of these structural steel caps carried bearing plates on which rested the ends of the timber trusses. The timber trusses for the typical bays were constructed of two pieces of 3-in. x 12-in. yellow pine as top chord, supported by two 1-in. truss rods, giving a total depth of truss of 3 ft. The top chord of these trusses was supported by two 8-in. x 8-in. timber struts situated at the third points. The form work proper was supported on a 4-in. x 8-in. ledger, hung underneath these trusses by ⅝-in. round hanger bolts spaced about 2 ft. 6 in. on center. These ledgers supported the ends of the transverse built-up frames, which, in turn, carried the panels on which the concrete was poured. One intermediate timber beam without truss rods, composed of two pieces of 4-in. x 12-in. timber, was supported at the same level as the trusses. The structural steel caps had a bearing plate at their center points to carry the ends of this intermediate beam. This beam supported, by means of hanger rods, the 2-in. x 8-in. spreaders, situated 2 ft. 6 in. on centers which carried the panels on which the concrete between the pile caps themselves was poured.

In order that the forms might be lowered without

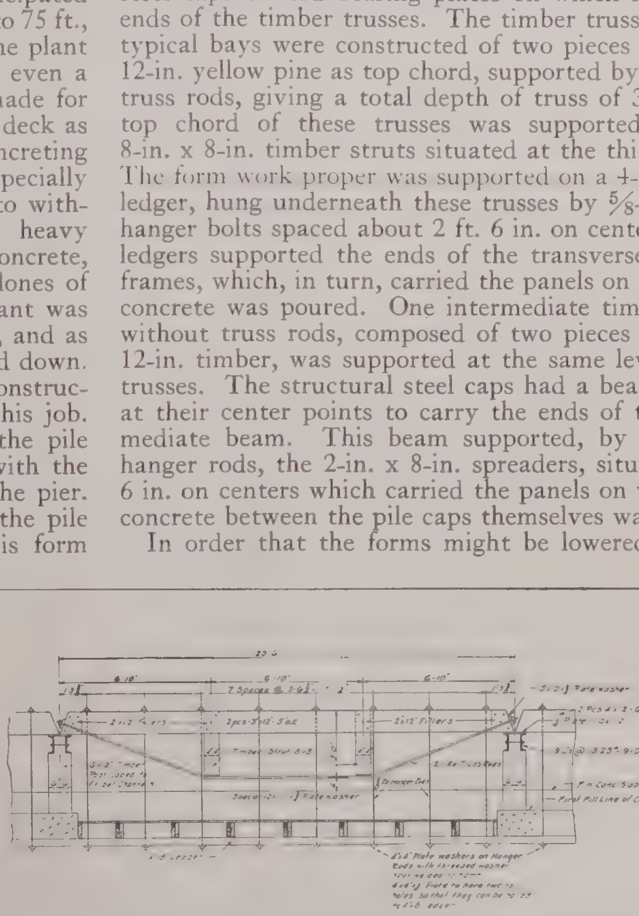

Fig. 5—Timber Truss for Typical Bay

sending a man underneath the deck, all of the hanger bolts were arranged with the threaded end down. These hanger bolts screwed into nuts, which had been welded to the 4-in. x 4-in. washers, which, in turn, had been fastened by two nails to the 4-in. x 8-in. ledger. In this way, no hanger bolts would be dropped into the water when the forms were struck, and the washers, as well as the nuts, remained fastened to the 4-in. x 8-in. ledgers.

The forms under the main deck were left undisturbed for seven days, inasmuch as, of course, it was impossible to do any reshoring. When the time had arrived for the forms to be lowered, the anchor bolts would be taken out from above, and as soon as the last bolt was released, the ledger would drop into the water, permitting the transverse girders and the panels resting upon them to also drop into the water, from which all parts of the forms were retrieved by men working on floats at low tide.

Precautions were taken so that there would be no question about the forms dropping when the hanger bolts were released, and for this reason no staples were permitted to be driven into the panels for holding the reinforcing steel in place. In the beginning of the work, a number of 6-in. x 6-in. holes were blocked out of the floor slab, so that if perchance the forms did not drop of their own weight when released, they could be pried down from above through these holes. After no trouble was found in dropping these forms, the pry holes were discontinued.

The trusses, timber beams, built-up frames, and other parts of the deck forms became very bulky if designed with the factor of safety generally used in designing permanent structures. The arrangement of the trusses and hangers permitted constant inspection to note deformation. A failure of a section of the deck forms would not have produced serious consequences. It was, therefore, decided to inspect carefully all materials before using, and design these forms with a factor of safety of two. The various parts of the deck forms were built on this basis and then carefully tested out before using, and it is interesting to note that there were no failures of either timber work or truss rods.

Tubes of corrugated paper were used around the hanger bolts where they passed through the concrete slab, and with this precaution, no trouble was encountered in releasing these bolts, even where they passed through 18 inches of concrete slab. The forms constructed as noted, were used about eleven times, and with the exception of some light panels, were found to be in good condition at the end of the work.

All of this work was done under the general supervision of Charles E. Lund, resident engineer for the Parklap Construction Corp. R. A. McMenimen acted as resident engineer for the Raymond Concrete Pile Co. on the foundation work done by them, and the superstructures by the Turner Construction Co. came under the control of R. C. Wilson, general manager; F. E. Schilling, general superintendent; W. W. Roberts, superintendent.

Effect of Alkali on Strength of Mortar

From paper by Charles E. Proudley, Junior Assistant Testing Engineer, U. S. Bureau of Public Roads, in *Public Roads*.

Tests of mortar briquets made in the laboratory of the United States Bureau of Public Roads to determine to what extent the presence of alkali in mixing water is harmful indicate that—

1. The presence of alkaline sulfates in the mixing water in quantities of less than 1½% has no serious effect on the strength or other physical properties of portland cement mortar.
2. 1% alkaline solutions in contact with cement mortar in mixes of 1:2 and leaner cause progressive decrease in the strength of the mortar.
3. The decrease in strength of mortar subjected to alkali action may be somewhat accelerated by the presence of considerable quantities of alkali in the mixing water, and for this reason the use of pure water in mixing is advisable under such conditions.

The specimens used in the tests were mortar briquets made with Ottawa sand and a good commercial brand of portland cement. The alkali used had the following analysis (average analysis of a number of alkaline waters in which sulfates are the principal salts):

	Per cent
$CaCl_2$ (calcium chloride)	4.50
$MgCl_2$ (magnesium chloride)	11.20
$MgSO_4$ (magnesium sulfate)	3.90
Na_2SO_4 (sodium sulfate)	80.40
	100.00

Specimens were made with mixing water containing no alkali, 1% alkali, 2½% alkali, and 5% alkali. The specimens were stored in water in the usual manner after the initial 24 hours in the moist closet. In a period of one year, the use of the alkaline water has no objectionable effect; in fact, the specimens in which it is used have a slightly higher strength than the standard briquets.

It is noticeable that more than 2½% alkali in the water does not have a correspondingly greater effect upon the strength, and for this reason later tests were made using less alkali. Furthermore, analyses[1] of water from rivers, lakes, springs, and wells from every part of the country show that less than 1% of the waters examined contain more than 1.5% alkaline salts by weight. In fact, comparatively few contain more than 0.5% of dissolved solids.

Tests were also made to determine the effect of alkali in contact with the specimens, some stored under usual conditions, other specimens cured in soil saturated with a saturated solution of alkali, and still others stored in a 1% solution of alkali.

It is noted that alkali in the mixing water in amounts of 1½% or less has an immaterial effect upon the strength, although a tendency toward slightly lower strength in this series may be noticed. This may be due to a number of causes, such as a slightly lower density resulting from the presence of the alkaline salts in some chemical combination with the cement or some of its constituents, or lower cementing qualities due to this chemical action alone. Where the specimens have been stored in alkali, it seems that the presence of alkali in the mixing water assists disintegration perceptibly.

Time of set and soundness tests on cement pats mixed with alkaline waters of various strengths show that neither time of set nor soundness is altered to any appreciable extent by the presence of alkali in the mixing water.

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[1] U. S. Geological Survey, Water Supply Paper 364.

Economical Handling of Raw Materials in Building Unit Manufacture

(Contributed)

One cause of needlessly high operating expense in many concrete products plants is a poor layout on the "raw materials" end—the part of the plant charged with the job of excavating and handling the aggregates—or their receipt, storage, and handling, where the aggregates come from outside sources. A layout may be a poor one, because it is defective in one or more of any number of ways.

It may not produce an adequate supply of aggregates in the first place, or it may not have the capacity to take care of an adequate supply after it is produced; it may be highly cumbersome and subject to frequent shutdowns for upkeep and repairs; it may involve a needlessly large number of operations (each of which costs money) or it may be that it cannot be worked economically at what should be its normal capacity.

A poor layout, however, is not intentional—no man deliberately sets out to obtain one—although we do find them all the time. Probably one of the easiest ways of achieving this undesirable end is to accept without reservation the prescription of the man with some specific method or machine to sell, particularly if this same man is not familiar with the ins and outs of concrete products manufacture. Of course, it must be admitted that not always are even "the best-laid plans" entirely successful, but they do have a higher percentage of successes to their credit than the other method.

Only one remedy suggests itself—for the products manufacturer to make haste slowly in committing himself to the installation of a machine or method with which he is not altogether familiar. This does not necessarily mean the familiarity of long use, but at least a knowledge of how the method or machine has been employed in other similar plants, the conditions under which it worked, and its record of performance.

Then, too, there are usually more than one or two ways of doing a thing in this world. Other methods may be equally appropriate for the job in hand, and cost less. The products manufacturer who can see that he is going to have to overhaul and enlarge the aggregate-producing end of his plant should give a little time to acquiring a general knowledge of the methods of excavating and handling material that have been employed both in other concrete products plants and in commercial sand and gravel plants, whose elaborate installations can often be scaled down to fit his more modest needs.

It is desirable, therefore, that the products manufacturer be able to sit down first and make a survey of the different methods of excavating and handling materials that are available to meet different conditions of pit and bank operation, in order that all suitable methods be given some thought. Selection can then be made of those methods which appeal most to the user, or best suit his individual problems, from the widest range of possible means of accomplishing the one aim.

It is accordingly the purpose of this article to present a brief summary of the methods in common use in excavating and handling sand and gravel, according to the conditions to be met. Crushed stone, crushed blast-furnace slag, and cinders, while commonly used as concrete aggregates, are usually obtained from sources outside of the scope of plant operation, and will not be considered here. Sand and gravel abound in natural deposits over most of the country, and form the principal aggregate supply which it is necessary to work as part of the plant operation and around which the majority of concrete products plants are built.

Sand (and by sand is meant sand and gravel, or pebbles) may be found either in a pit or in a bank. However, if the pit is dry, and of any extent so that the excavating machinery may be placed down in it, it becomes a "bank" to all intents and purposes as soon as it has been excavated to sufficient depth to present a "working face," and much the same methods and machinery can then be used as in a hillside bank.

For "bank" excavation, the following methods may be used:

(1) Hand
(2) Slips
(3) Wheeled scrapers
(4) Portable loaders
(5) Power shovels
(6) Dragline excavators.

For pit excavation, two different conditions have to be considered:

(1) Dry pit.
(2) Pit wholly or partly under water, or in a stream.

As before stated, after a dry pit has been excavated to a slight depth, it can be worked by many of the methods used with a bank. There are, in addition, other methods which are not suitable for bank excavation. Listing all the methods in general use, we have:

(1) Hand
(2) Slips
(3) Wheeled scrapers
(4) Portable loaders
(5) Power shovels
(6) Locomotive cranes with grab-bucket or dragline
(7) Dragline cableway excavator.

Where the level of the ground water is such that the pit is constantly filled (or if the pit is in a stream) and excavation must be conducted under water, the methods generally used are:

(1) Dragline cableway excavator
(2) Suction pump
(3) Derrick (where flow of stream fills pit with new material as fast as it is excavated.

After the sand has been excavated it must be conveyed from the bank or pit to the plant or to a storage pile, if it is not loaded on trucks or cars for sale. Washing and screening may or may not be necessary, but the equipment necessary for this operation may be considered as aside from the scope of this article for the sake of simplicity. If washing or screening is to be done, however, that fact should be borne in mind when studying the methods of operation, for the necessity of getting the materials to the screens, etc., may have considerable bearing on the choice of method to be adopted.

There are a number of methods by which the aggregate may be conveyed from the bank or pit to the plant or storage pile. They are not all interchangeable, one for the other, with each of the methods that can be used for excavating; and in some cases, as with the use of slips and scrapers or draglines, the operations of excavation and transportation are combined in one. For convenience in checking over, however, they are all given herewith:

(1) Slips
(2) Wheeled scrapers
(3) Trucks
(4) Industrial "v" car on narrow-gauge track
(5) Belt conveyor
(6) Cableway dragline excavator
(7) Pumping.

Each of the methods listed above has its own individual characteristics, as will be shown; these characteristics will vary greatly, and must be given consideration when making a decision as to the methods to be adopted—a machine or method that is eminently suited for one plant or set of conditions may be, and frequently is, entirely unsuited to the next plant with its own set of governing conditions.

One point which has to be given special consideration in this day of rapid expansion in the concrete products industry is that of capacity. An installation that will not have the capacity to meet easily the maximum operating demands of the plant, with some surplus capacity for future growth, has no right to consideration. This seems absolutely elementary, but it must be remembered that mechanical equipment does not always work at the rated capacity given in the manufacturer's catalog, not through any fault of the manufacturer necessarily, but because shutdowns caused by both the human and mechanical equation are unavoidable. When such cases do occur—because the operator is laid up sick, or because new cables must be installed, or a job of re-babbitting done, etc.—the machine whose rated capacity is just enough to take care of the expected demand is not going to have enough surplus or reserve material ahead to avoid a tie-up in the manufacturing operations. In addition, it is generally less expensive in the long run to operate a larger machine at a moderate pace than to force a smaller one to maximum capacity all the time.

As the study is carried along, it will be found that several machines will have the necessary capacity for the method or methods under consideration. The study must then be carried one step further by finding out which machine is the least expensive—not simply to buy, or to buy and install—but in the sum total of purchase price, labor and power to operate, interest on investment, and with due allowance made both for depreciation and repairs, bearing in mind that the latter items are much higher for some types of machinery than for others.

The use of a checking list of methods of excavating and handling material similar to those already given herein will help to ensure that all the methods that are applicable to the problem in hand have been given consideration. Then if the cost estimates for each of the types of machinery under consideration are prepared along uniform lines, taking into consideration the items mentioned above, a fairly accurate indication should be had as to the methods which will prove most economical in the long run. Personal investigation and check up of plants where these methods have been used will then point to choice of the most desirable one for the plant under study.

Notes on the methods of excavating and handling that are most commonly found in use in concrete products plants are given herewith. Some of the methods mentioned in the foregoing tabulations are of such a special character that it would be useless to attempt to give data with regard to them; they are included in the list so that the products manufacturer in his study of possible methods for use in his particular operation may not overlook their existence. The advertising pages of his technical magazines will give him the names of the firms who handle equipment of these kinds, and he can then find out from them what are their recommendations for the conditions to be met at his plant. [The Service Department of CONCRETE will be glad to help in locating the right equipment.—Editor.] These recommendations should naturally be made in such a way as to give the products manufacturer the same information relative to costs for equipment, installation and operation, etc., that he is getting with regard to the other types of equipment, so that a fair comparison can be made on the same basis for all.

HAND LABOR

Data on hand labor seems to vary considerably according to the source from which the information is drawn. If is, of course, also subject to the variations occasioned by local conditions—the demand for labor or the lack of it, and an accompanying unwillingness or willingness to do a full day's work, as the case may be. The figures quoted here have been checked up with a number of authorities and seem to be fair averages.

Working in sand 1 man will ordinarily:

Loosen with pick about, per hour	6 cu. yds.
Dig with shovel in unloosened material and shovel per hour	1–1¼ cu. yds.
Shovel into wheelbarrows, where material is already loosened, per hour	2 cu. yds.

Shoveling into trucks or cars is very largely affected by the weight of the vehicle, as well as the nature of the material to be handled. Heavier materials and those more difficult to handle naturally take longer. It is claimed by some that in loading jobs of short duration, as in shoveling into trucks, where the work is done in spells of ten minutes or less, the men will work much faster than will be indicated by their average for the day. A double table is thus prepared, one half for the time the men are actually shoveling, which determines the number of men required to load a truck of any given capacity in a fixed time, (or the number of minutes that will be required for any combination of truck capacity and number of men, and the other half, which gives the daily capacity per man for different materials, which determines the number of men, and consequently the cost, involved in handling any quantity of material per day. A man's output will naturally vary with the height to which he must lift the material he is shoveling.

TABLE 1—SHOVELING CAPACITY

Height of Lift Inches	Cubic Yards per Minute (10 minutes or less)		Cubic Yards per Day	
	Sand	Crushed Stone	Sand	Crushed Stone
42	.07	.042	19	11.5
48	.06	.036	16	10
54	.051	.030	14	8.5
60	.045	.027	12	7.25

Assuming that shovel laborers cost $4.00 per 8-hr. day, the cost of hand loading (on the basis of the number of yards per day given above) figures out to be:

TABLE 2—SHOVELING COSTS

Height of Lift Inches	Cost per Cubic Yard (Average Day's Work)	
	Sand	Crushed Stone
42	$0.21	$0.348
48	0.25	0.40
54	0.285	0.47
60	0.33	0.55

These figures cover only the labor cost of actually loading the material into cars or trucks. They do not take into consideration the truck-time lost during the loading operation. There are 480 minutes in an 8-hr. working day, so that we can say that for every $5.00 per day paid for a truck, it costs roughly 1¢ per min. to keep it waiting, or for a $25.00 truck 5¢ per min. and so on.

Assuming that we will put enough men on the trucks so that each man will load only ½ cu. yd. of material, we can find out from Table 1 how long it will take to load a truck with either sand or crushed stone, for the four different heights of truck-body quoted. The costs given in this table are on the same basis as mentioned before—1¢ per min. for every $5.00 per day paid for the truck. To get the cost for any truck, multiply the "cost per load" from Table 3 by the number of times that $5.00 will go into the price being paid for the truck.

TABLE 3—TRUCK WAITING COSTS WHILE LOADING

	SAND		CRUSHED STONE	
Height of Lift Inches	No. of Minutes Required	Cost per Load @ $5.00 Per Day	No. of Minutes Required	Cost per Load @ $5.00 Per Day
42	7.1	$.07	11.9	$.12
48	8.3	.08	13.9	.14
54	9.8	.10	16.7	.17
60	11.1	.11	18.5	.19

Where it is necessary to wheel material short distances, laborers and wheelbarrows can be used, though for more than about 75 or 100 ft. it will be well to investigate the possibilities of horse-drawn slip scrapers. In "Trautwine" the following information is given:

> A man wheels at about 200 ft. per minute—this is equivalent to a travel of 100 ft. going and 100 ft. returning, (the distance the material is to be moved is technically called the "lead"—100 ft. in this case), loading and emptying when wheeler loads amount to about 1.25 min. Lost time amounts to about 1/10th of total time. To find out the amount a man can load and wheel for any distance, we use the simple formula which gives the number of loads per day,
>
> $$\frac{480 \text{ (no. min. in 8-hr. day)} \times .9 \text{ (effective working time)}}{1.25 \text{ (time loading, emptying, etc.)} + \text{(number of 100 ft. leads)}}$$
>
> Working this out for a 100-ft. lead, we get:
>
> $$\frac{480 \times .9}{1.25 + 1} = 192 \text{ loads.}$$
>
> As there are about 14 wheelbarrow loads per cu. yd. of sand in place, we then divide 192 by 14, which gives us between 13 and 14 cu. yds. as the amount that a man can load and wheel 100 ft.

These figures are undoubtedly high for present-day labor conditions except where work is scarce.

SLIPS

Where material has to be excavated and moved a short distance, a "slip" or "slip scraper" drawn by a team is very generally used. They are usually considered unsuited for moving material a greater distance than 150 or 200 ft. The "slips" themselves, which are, practically, greatly enlarged sugar scoops with handles and a bail, are made with rated capacities of 3, 5, and 7 cu. ft. As they are seldom completely filled, only about 75% of the rated capacity should be figured.

For the most economical operation of slips, it is customary to work with about three teams in a circle 150 to 250 ft. in circumference. One man in the pit turns the scrapers into digging position and guides them in turn until they are filled. Each team requires a driver, who also dumps his slip by turning it over at the unloading point.

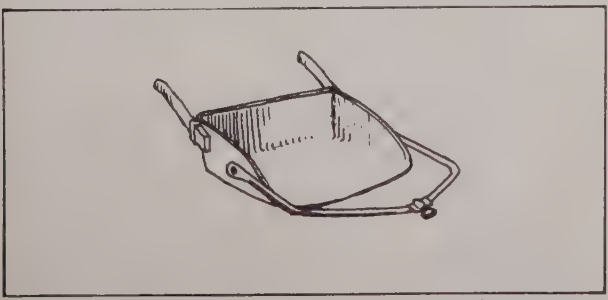

FIG. 1—SLIP SCRAPER

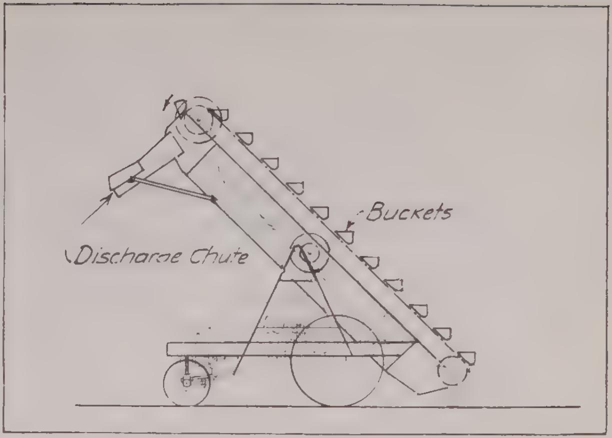

FIG. 2—PORTABLE DIGGER OR TRUCK LOADER

Those who have a special problem relating to the use of slips or wheeled scrapers, in which it is necessary to figure fairly closely the effect of hauling different distances on output and cost, are referred to Trautwine's *Civil Engineer's Pocket Book*, in which will be found very simple and complete rules for this purpose. For general purposes, however, the following figures are usually considered sufficiently accurate:

On a 25-ft. haul, one man with team and slip scraper will make a round trip in 1½ min., and will excavate and move 5 yds. of earth per hr.

On a 50-ft. haul, it will require 2 min. for a trip, and one man and team will excavate and move 4½ yds. per hr.

On a 100-ft haul, it will require 2½ min. per trip, and one man and team will excavate and move 4 yds. per hr.

On a 200-ft. haul, it will require 3½ min. per trip, and one man and team will excavate and move 3½ yds. per hr.

WHEELED SCRAPERS

Where the distance to be covered is outside the economical range of operation for slip scrapers, a wheeled scraper is used instead, having an effective range of from 300 to 600 ft. Wheel scrapers run in capacity from 10 to 16 cu. ft., manufacturer's rating.

With large quantities of material to be moved, wheel scrapers should work in gangs of from 4 to 6 for hauls up to 400 ft., and in gangs of from 8 to 12 for longer hauls.

It is estimated that a two-horse team and wheel scraper can move, in a 10-hr. working day, the following average amounts of loose material:

For a haul of 100 ft.	60 cu. yds.
For a haul of 200 ft.	50 cu. yds.
For a haul of 300 ft.	40 cu. yds.
For a haul of 400 ft.	30 cu. yds.

PORTABLE DIGGERS

Where the haul from pit to plant is so long that slips or scrapers cannot be used, a skip, side-tip or "V" cars, or belt conveyor may be employed. It is frequently necessary to load these more quickly than can be done by hand. In this case, or where a greater output is required regularly than can be had by hand labor, portable diggers or "truck loaders," as they are sometimes called, are used. We here enter the realm of mechanical devices which are made in such a multiplicity of designs, with such a range of capacities and

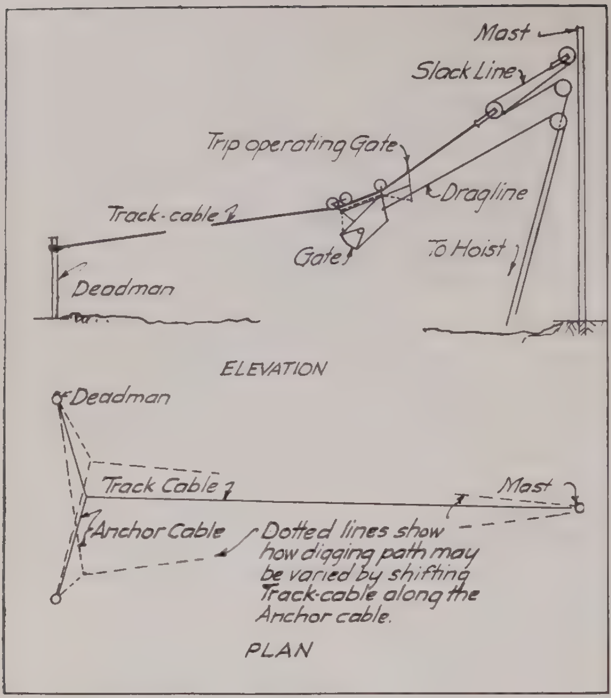

Fig. 3—Dragline Excavator Layout

with such wide variance in price, that it is impossible to catalog them all, even briefly.

Suffice it to say that if there is a place where it is desirable to shovel material up from the ground, or in the case of sand, dig it from the bank, and elevate it for discharge into a truck or other means of transport, the portable digger is probably the least expensive machine for the job.

They are usually made with a rated capacity of 1 to 1½ cu. yd. per min., and while manufacturers quote many instances where the rated capacity has been greatly exceeded, it is well to make a generous allowance for loss of efficiency when the material is scattered or does not run just right to keep the buckets filled to capacity. One man is usually required to tend the machine, look after the engine, keep an eye on the way the material is feeding, etc.

These machines are operated by gasoline and electric motors as required. They come in a variety of mountings—wheels, caterpillar tread, and Fordson tractor. They have fixed and swivel discharge chutes or measuring hoppers to enable continuous machine operation and periodical discharge, as to trucks or cars. Some are self-propelling. To ensure that the buckets shall be kept filled, a number of expedients are adopted to force a flow of material into the path of the buckets. Some machines use large rotating discs, other propeller blades, and in still other types large serrated spiral blades similar to screw conveyors dig and shovel the material to a point where it can be picked up by the buckets. One machine has a 5-ft. extension arm, under which the buckets travel horizontally as scrapers to ensure full loading before they are elevated. A device for "crowding" the machine into the pile or bank is provided on most machines; it may be manually or mechanically operated, or entirely automatic, with the rate of movement adjusted to the speed at which the machine digs.

The prices run from $875 (and in some cases less) to as high as $4000, according to the type of machine and the work it is intended to perform.

Power Shovels, Draglines, etc.

Where greater ability to dig, or greater yardage capacity, is required than can be had with a portable wagon loader, some form of steam shovel or excavator is used. There are many makes and types now on the market. There are the small revolving steam shovels with dipper capacities of from ½ cu. yd. up. Then there are various modifications of the type of machine known generally as the Keystone excavator, in which the bucket is mounted at the end of a jointed arm and is drawn in toward the machine, which is well adapted for digging into pits and excavations below the level of the ground on which it is standing. This and similar machines, are generally used for "skimming" or "stripping" the surface—removing a comparatively thin layer.

The dragline excavator is used where it is necessary to cover a wider area than can be reached from one position with a steam shovel or similar outfit. A special type of scraper bucket is drawn in toward the machine by cables. These cables are carried by a boom, which may be of wood or lattice steel construction, and the effective working range of the machine is limited only by the length of the boom used. Bucket capacities run from ½ cu. yd. up, and booms all the way from 30 or 35 ft. to as much as 150 ft. Many types of portable digging machines, such as locomotive cranes in particular, can be readily converted into dragline excavators, by slight changes in their rigging and the use of a dragline bucket. Lengthened booms can also be used to extend the area covered, but only with the approval of the manufacturer, who is able to tell just what strains can and cannot be imposed on his machine.

Most of the various kinds of equipment listed under this head can also be had equipped for gasoline or electric operation as may be desired. Steam shovels, locomotive cranes, etc., usually can be had in a variety of mountings—wide-tread wheels, caterpillar tread, etc.

The range of working capacity and purchase price is almost unlimited. When it becomes necessary to consider the purchase of equipment of this type, involving a heavy investment, two points are of outstanding importance:

First: Make your selection only after a study and discussion of the manufacturers' catalogs with their sales representatives have fixed in your mind the more important features of the different makes. Then visit plants where the different machines are in operation and watch them at work; talk to the men who are running them, and to the fellows in the office who are footing the bills for repairs and replacements, as well as lost time, if any. Generally speaking, it is well to bear in mind that no first-class manufacturer can afford to put out a poor machine, and the first cost is not the last. Usually high upkeep charges will soon offset any apparent economy effected by buying the cheaper piece of equipment.

Second: After you have bought the machine—see that it is run by a man who is competent to run it and take care of it. No machine will withstand continued abuse, a fact we all know, but an inspection of any products plant will reveal an endless amount of equipment that is not being properly kept up, in spite of the fact that sand is highly abrasive, and that special care is required for the proper maintenance of machinery handling it.

The following information was supplied by the Erie Steam Shovel Co. for Barnes' *Estimating Building Costs and Appraising Buildings* (1924), and indicates the more important items on equipment of this type:

Revolving Steam Shovel

Capacity of Dipper	Type "A"	Type "B"
Rated Capacity per hr.	½ cu. yd.	¾ cu. yd.
Deep cut	30–40 cu. yds.	50–60 cu. yds.
Shallow cut	15–25 cu. yds.	25–35 cu. yds.
Approximate price f. o. b. factory		

On traction wheels...........	$6,250	$7,200
On caterpillar mounting......	$7,750	$9,000
Fuel required at capacity 10 hrs.....	1,000 lbs.	1,500 lbs.
Water required at capacity 10 hrs....	1,000 gals.	1,500 gals.

Crew consists of an operator, fireman, and usually two pitmen.

Upkeep and repairs, oil and waste will run about $2.00 per day.

Depreciation. Manufacturers estimate life of properly cared for machine at 2000 working days, at which rate the depreciation would be from a little over $3.00 to $4.50 per working day, according to the price of the machine in the table above.

Interest on investment must also be included.

DRAGLINE CABLEWAY EXCAVATORS[1]

Where excavation has to be carried on over long distances in the dry or under water, the dragline cableway excavator is the piece of equipment most frequently used. It is shovel, conveyor and elevator, if necessary, all combined, and it is operated entirely by one man.

Essentially, the excavator bucket is suspended from a trolley which runs on an inclined wire rope track, extending from the upper end of a mast of proper height—50 to 100 ft.—to any suitable anchor—a tree or deadman—out where the materials are to be dug. The inclination of the cable on which the trolley travels must be such that the bucket and trolley will run down rapidly and freely.

A two-drum hoist operates the excavator. Two lines are used—the load line or "dragline" and the "slackline," which latter is so arranged that by a system of blocks it can tighten or slacken the track rope on which the trolley runs.

When the clutch on the drag line drum is released, the bucket runs down the track line, its speed under brake control at the hoist. Reaching a point over the material to be dug, the track line is lowered by paying out the slack line at the hoist. When the bucket rests on the material to be dug, the hoist hauls in on the dragline, and the bucket picks up its load as it is dragged forward. Then the slack line is hauled in, raising the track line and lifting the bucket out of the material to be hauled rapidly up the track line by the dragline.

At the desired dumping point—which may be anywhere along the track line—the dumping trolley ahead of the bucket strikes a stop-casting clamped to the track line, which causes the rear dump gate to open and the load to drop out. This completes the cycle of operations, and the bucket is then allowed to run down the track line for another load.

In many situations, the bucket may dig for long periods with one setting of the outer anchorage or deadman, particularly in the beds of streams where there is constant filling of excavated holes by the washing in of new material. Where frequent shifts of the digging must be made, the labor of moving deadman anchorages may be avoided by stretching a cross-rope between two trees or deadmen anchors and clamping the track line to this rope in such a way that it can readily be moved when desired.[1]

As will be seen from the description of the operation of this equipment, it has several valuable characteristics. It will operate over long spans and dig under water. Only one man is required for operation, and if there is an area of vacant land along the line of travel and close to the plant, a reserve storage can be built up and reclaimed with the same equipment. It will deposit equally well into a hopper at the ground level or into a high storage bin, without change in operation. Steam or electric power may be used.

The buckets may be had in capacities of ½, ¾, 1, and 1½ cu. yd. Digging speeds vary from 150 to 225 ft. per min.; the conveying speeds from 250 to 600 ft. per min.; and slack line speeds 175 to 250 ft. per min. Based on an average of 30 to 40 trips per hr. over a span or travel of 300 ft., it is estimated that different-sized buckets will excavate and transport:

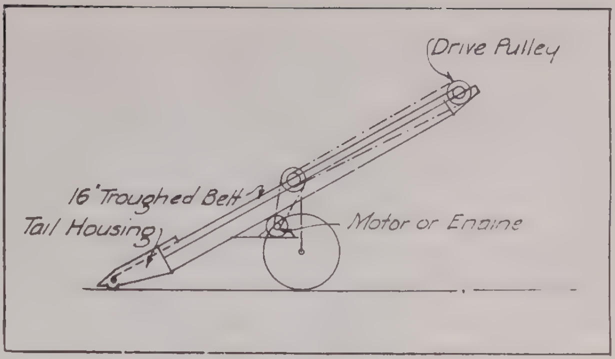

FIG. 4—TYPICAL PORTABLE BELT CONVEYOR AND ELEVATOR

¾ yd. bucket..................	22 to 30 cu. yds. per hr.
1 yd. bucket.................	30 to 40 cu. yds. per hr.
1½ yd. bucket..................	45 to 60 cu. yds. per hr.

The power requirements will vary with the length and speed of haul, as well as with the size of the bucket. These factors will also affect the price. An approximate figure for bucket, trolley, dump trolley, and dump bottom, or, in other words, the bucket and appliances, but not including mast, hoisting engine, and cable is given as:

¾ yd............................	$ 800 to $1000
1 yd............................	$1000 to $1200
1½ yd..........................	$1200 to $1500.

PORTABLE BELT CONVEYORS

For small plants, where an all-around conveying and elevating machine is required, one of the many types of portable belt conveyors is undoubtedly best. These machines are low in initial cost, light in weight, and may be easily moved from place to place; and they will load sand and gravel or stone in the pit or handle cement at the plant with equal readiness and facility. They can be used to good advantage where men would ordinarily be required to shovel material into high trucks, thus increasing their working capacity; or where one man with a shovel can pull down from the bank a continuous flow of material onto the belt, which would otherwise require a half-dozen additional men to load into the waiting truck or car.

They are also useful in building up and helping to reclaim from storage piles. They come in stock lengths of 20, 25, 30, and 35 ft., and can be made longer if required. These lengths are the length of the belt, which is, of course, at an angle; the horizontal distance covered is somewhat less.

Power is furnished by electric motor or gasoline engine. They are generally figured to operate with a belt speed of about 200 ft. per min., and will handle up to 1 ton per min. if facilities are provided for feeding material to them at that rate.

Prices for one make, range all the way from a little over $400 for the 20-ft. machine without power, or a little over $500 with electric motor, to $825 for the 35-ft. machine with motor.

BELT CONVEYORS

A belt conveyor is as nearly foolproof as any piece of machinery made. There is very little about it to get out of order, the wear and tear is relatively small, and it has a high capacity for transporting and elevating material. It will not dig.

In its simplest form, a belt conveyor consists of a head and tail pulley, with the necessary driving gears

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[1] Author acknowledges indebtedness to Link-Belt Co.'s catalog for the foregoing description which he has copied practically verbatim.

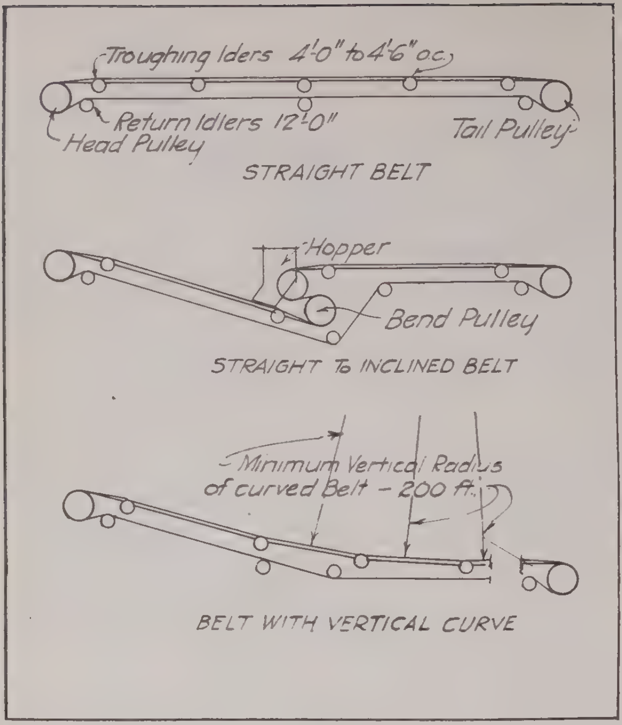
Troughing Idlers 4'-0" to 4'-6" o.c.
Return Idlers 12'-0"
Head Pulley
Tail Pulley
STRAIGHT BELT
Hopper
Bend Pulley
STRAIGHT TO INCLINED BELT
Minimum Vertical Radius of curved Belt – 200 ft.
BELT WITH VERTICAL CURVE

Fig. 5—Belt Conveyor Practice

and motor on one end, and a "take-up" for keeping the belt taut at the other end. The belt passes over a series of idlers, or pulleys, which, in the case of belts for handling sand and gravel or stone, are so placed as to give to the belt a trough-like or cup-shaped cross-section. Underneath the simple framework which supports the pulleys and troughing idlers, another set of idlers is placed, more widely spaced than the troughing idlers, to carry the return belt.

Where it is wished to elevate the material as well as carry it, the belt may run horizontally the required distance, and then change its direction to a gradual slope upward. This requires that a vertical curve be used, which should be of not less than 200 ft. radius. Crushed stone can be handled on slopes up to 18°, sand up to 22° and sometimes 25°. Premixed aggregates—sand and gravel correctly proportioned at the bank—have been handled on belts having slopes just under 30°. Generally speaking, fine material can be handled at higher angles than coarse, and material uniformly loaded on the belt will ride successfully at higher angles than the same material in occasional batches, where there is an opportunity for it to roll down the slope.

According to the manufacturer's formulae, the power required for belt conveyor operation is not very high, but it is generally considered good practice not to use anything less than 5 h. p. for belts under 200 ft. in length, and 10 to 15 h. p. for belts up to 500 ft. in length. For inclined belts, it is usual to add 1/1000 (one one-thousandth) horse power for each foot ton lift per hr.

For handling sand and gravel or stone, it is customary to use an 18-in. wide belt, 4- or 5-ply rubber. An idea of the immense capacity of such a belt may be gained from the following table, based on an 18-in. belt:

300 ft. per min. belt travel	160 tons per hr.
250 ft. per min. belt travel	130 tons per hr.
200 ft. per min. belt travel	110 tons per hr.

The capacity at various other speeds, or the speed required for any given capacity, may be figured from above with sufficient accuracy. Thus, for 16 tons per hr., 1/10th of 300 ft. per min., or 30 ft. per min., would be enough, for the same width of belt.

Prices of belts, pulleys, gears, etc., all vary with the different manufacturers. Taking the figures from one catalog, however, we find that roughly the costs for belts of varying lengths are as follows:

50 ft.	$1,500
100 ft.	2,500
200 ft.	4,500
500 ft.	10,000

Side Tip "V" Cars

For straight transportation between bank and plant, side tip "V" cars are frequently used. They run on inexpensive narrow-gauge track (24 in. or 30 in.) and come in various capacities from a fractional part of a yard to several yards. They can be made to serve as measuring hoppers by gauging them so that they will carry only enough material for one batch. Cars and track both can be picked up from any dealer in used contractors' supplies, and will stand a lot of abuse.

Where the bank is being worked at a higher elevation than the plant, the tracks can be given a slight slope to the plant, thus making it possible for one man to push the loaded car readily.

The cars can be pulled by gasoline, electric, or compressed air locomotives if necessary, but this will rarely if ever be required in the average products plant. An inexpensive layout is indicated in an accompanying sketch, which shows a double-track arrangement by which one man and a two-drum hoist can handle up to 60 cu. yd. per hr., if facilities are provided for quick loading of the cars, such as an overhead bin or hopper. The cable passes around two tail sheaves at the far end of the tracks, so that as the loaded car is drawn to the plant, the empty car is being hauled to the bank.

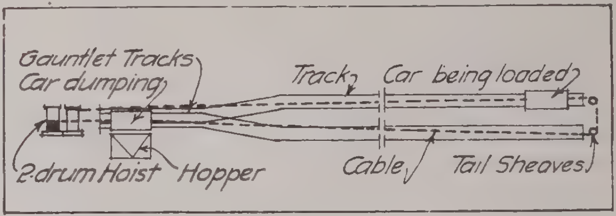

Fig. 6—Method of Using Side-Tip "V" Cars for Hauling Sand From Bank to Plant with Double Drum Hoist

The above speed can be maintained over hauls up to about 250 ft. A 15-h. p. motor will furnish ample power for such an installation. For high speeds, it may be necessary to "lag out" the hoist drums, and the track itself should be carefully leveled or derailments will be frequent.

To Prevent Sand from Shifting in Wind

To prevent the beach sand on Rockaway Point, Queen's County, N. Y., from blowing from under a concrete service driveway built by Bellevue and Allied hospitals, beach grass has been planted along the sand shoulder, the roots being set to their normal depth of 6 in. to 8 in. It took four men between four and five days to dig up the grass and replant it, on a 300 ft. strip of pavement, representing a cost of about $250, or about 10¢ per sq. ft. of pavement. This is according to Fred G. Lemcke, supervising engineer, Bellevue and Allied hospitals, in the *Concrete Highway Magazine*, of the Portland Cement Association.

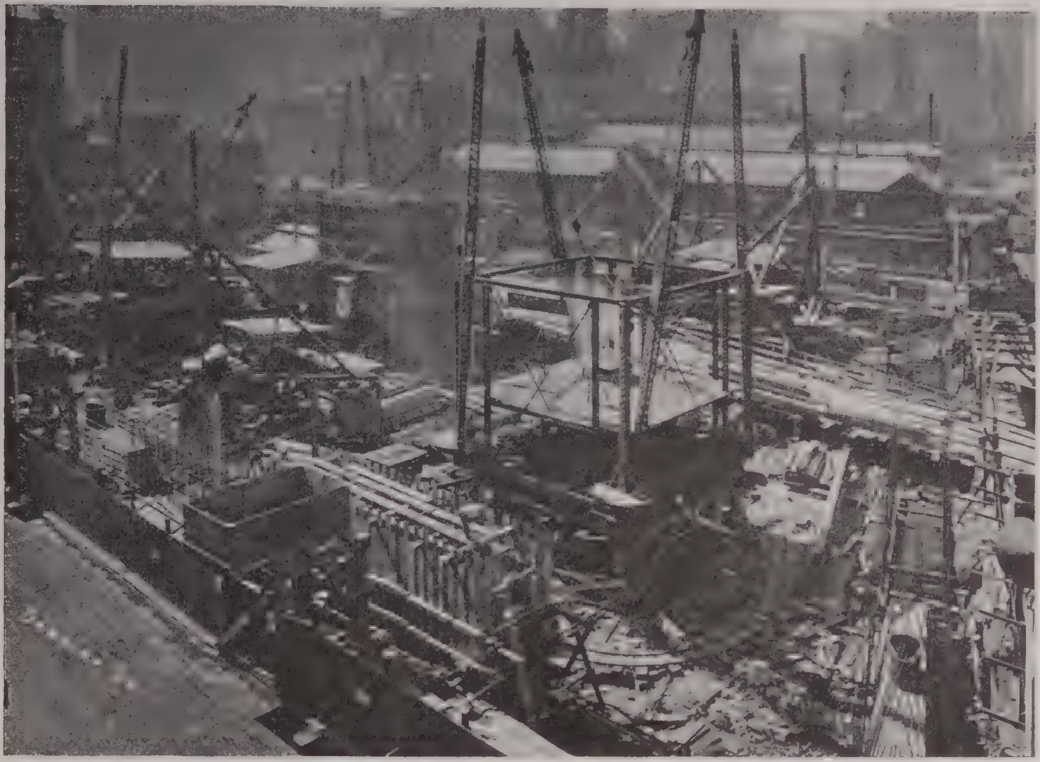

FIG. 1—FOUNDATION OF BARCLAY-VESEY BUILDING UNDER CONSTRUCTION. A LARGE INSTALLATION OF COSTLY EQUIPMENT WAS REQUIRED, SOME OF IT UNDER A LARGE TEMPORARY STREET-LEVEL DECK

Construction Methods and Plant for Substructure of Barclay-Vesey Building, New York

BY FRANK W. SKINNER

One of the most up-to-date buildings in the world is the 213- x 259-ft. Barclay-Vesey St. office building now being constructed for the New York Telephone Co. It will have a height of 434 ft. above the curb, and will extend four stories, or 63 ft., below the curb to the lowest of its 33 floors. It will cost about $10,000,000, and with the exception of one store floor at street level, will be used by the Telephone company only. It is situated near the water front of the North River, where it was necessary to carry the deep excavation for the basement stories, and the deeper ones for the rock foundations, through quicksand, water, and masses of stone and timber obstructions to a maximum depth of 80 ft. below ground water level.

The dimensions of the building, local requirements, and subterranean conditions indicated by preliminary diamond drill borings, made by Phillips & Worthington, necessitated the use of pneumatic caissons, and to minimize the amount of this costly work, the subterranean dam type of construction was adopted.

All four sides of the lot are completely enclosed by 22 long, narrow, pneumatic caissons of reinforced concrete, like a row of bricks on edge, separately sunk end to end and afterwards connected by watertight joints to make a continuous foundation wall extending down into solid rock.

This wall excludes ground water, resists tremendous external pressure, and permitted the quicksand it enclosed to be stabilized by draining so as to be easily removable by open excavation.

The caissons, about 40 ft. long, were built in sections of reinforced concrete extended up in successive 8-ft. courses, as the caissons were undermined by a total force of about 100 sand hogs working continuously in successive shifts in a maximum pressure of 35 lb., which necessitated 10 shifts of sand hogs in 24 hours.

The caissons required heavy loading to overcome tremendous skin friction, due to their extremely large vertical surfaces. All spoil was hoisted in cylindrical buckets through the airshafts and dumped through elevated loading hoppers to motor trucks that hauled it to dump scows.

After completion, the adjacent ends of the caissons were temporarily joined by steel sheeting which, with some wooden piles, were driven by a No. 6 and a No. 7 McKiernan-Terry hammer,[1] after which the caissons were connected by watertight concrete vertical keys made under air pressure.

As fast as general excavation inside the caisson wall progressed, tier after tier of huge temporary cross-lot transverse and longitudinal braces, shown in Fig. 4, were built in successive horizontal plane from the top down, to resist the enormous exterior pressure until it can be transferred permanently to the heavy steel girders and concrete floor slabs designed to resist it.

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[1] McKiernan Terry Drill Co., New York City.

The character and importance of the work and the enormous outlay involved in the building, required the most safe, rapid and efficient construction, and the methods, plant, and equipment for the execution of the $2,000,000 substructure contract of the most advanced type.

So much heavy plant was installed, such large quantities of bulky materials were handled, and so many men were employed that much more space was needed than the entire area of the lot afforded.

Obstructions were not permitted in the streets, which enclose all sides of the lot, and special provisions were made for the location, management, and operation of the heavy equipment and for the storage and handling of materials to prevent delay, obstructions, and unnecessary work like moving heavy plant, rehandling materials, etc.

An overhead receiving and distributing system and the loading and unloading of the large fleet of trucks constantly employed at street level, greatly increased working space in the bottom of the preliminary general excavation down nearly to water level, which covered the entire area of the lot. A complete system of numerous fixed and movable interlocking derricks commanded the whole area and adjacent parts of the streets, and provided for the rapid handling of all supplies, materials, and equipment not dumped from trucks and for the installation and shifting of the heavy machinery.

PRELIMINARY EXCAVATION AND PLANT INSTALLATION

After the demolition to street level of the 29 low, old buildings, formerly occupying the site, the Foundation Co., contractor for the $2,000,000 substructure, commenced operations, June 1, 1923, by the removal of about 3000 yds. of debris and earth down to the basement floor level at elevation, about 5 ft. below the curb and just about ground water level. The spoil was loaded by hand into about six 5-yd. automobile trucks, each averaging about eight round trips per 8-hour shift to Pier 47, North River. At the pier, the trucks dumped into large scalepans, that, in turn, were dumped into 800-yd. barges, towed out to sea and dumped. To permit the entrance and exit of the trucks in the foundation pit, two temporary earth ramps were provided, connecting it with Vesey St. and Barclay St., and were removed after the preliminary excavation was completed.

A T-shape working platform, supported 11 ft. above the bottom of the excavation on heavy timber bents, was immediately constructed, with exits at curb level on Barclay, Vesey, and Washington Sts., two of them being provided for the entrance and one for the exit of motor trucks handling all material and equipment in and out of the yard.

Simultaneously with the construction of this platform, there were installed a system of derricks, a cement storehouse with a capacity of 9000 sacks, or 2250 bbls, and, located largely under the platform, small temporary offices, shops, and storerooms, besides which there were provided a locker and bath house for sand hogs, two hospital sheds, time-keepers' and material checkers' offices at platform level, and other temporary structures.

All were arranged to clear most of the caisson locations, so that it was necessary to shift very few of them and to alter the platform only for the construction of three of the caissons. The entire area of the lot was thus made available for the large amount of material and equipment necessary, and provisions secured for an enormous amount of loading, unloading, and truck movements at street level without obstructions or delays.

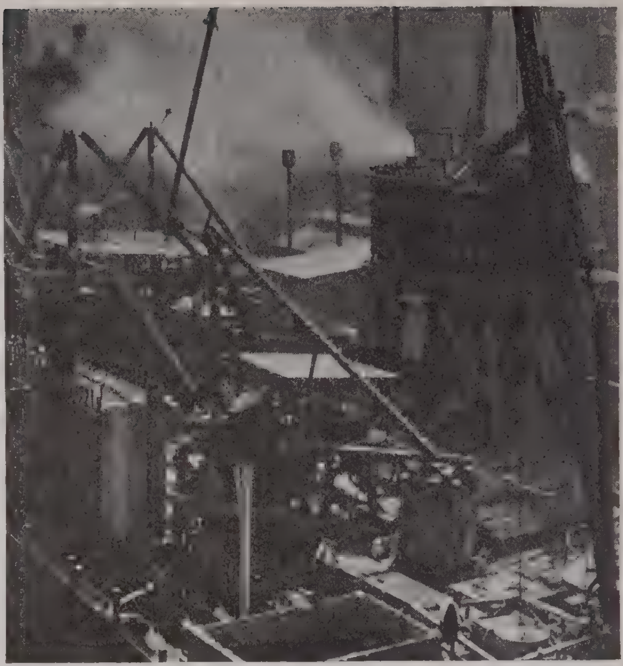

FIG. 2—CAISSONS UNDER CONSTRUCTION UNDER CONDITIONS MADE MORE DIFFICULT BY LIMITED WORKING SPACE

Round piles, sheeting, and Lackawana steel piles[2] temporarily closing spaces between caisson ends were driven by two McKiernan-Terry hammers[1] operated by a McKiernan-Terry air compressor.[1]

The excavation was drained to two 6- x 8-ft. open sumps, about 10 ft. deep, at opposited ends of the lot diagonal. One sump was drained by a Lawrence Vortex electrically driven centrifugal pump,[3] and the other sump was drained by a centrifugal pump, operated by a Westinghouse motor,[4] besides which there were installed for general purposes two 2½-in. plunger steam pumps.

The sump pumps were in more or less constant service, and were automatically controlled by float valves.

The derrick system included two four-boom steel travelers, two two-boom timber travelers, and four wooden stiff-leg derricks. All booms were 60 ft. long, and the tackles were rove with about 15,000 ft. of Broderick and Bascom ⅝-in. yellow strand steel cables.[5] The derricks were equipped with 16 two- and three-drum Lidgerwood hoisting engines,[6] five Lambert,[7] five miscellaneous makes, and five Lidgerwood swinging engines.

Together these derricks commanded the entire area of the lot and handled all plant material and equipment, except what was dumped or unloaded by hand from trucks. The compressor plant, the concrete plant, and an industrial track for the distribution of concrete were also installed. There was provided a lighting system of about twenty-five 500-watt Western Electric flood lights on poles about 25 ft. high and on the derrick frames, that afforded illumination, permitting the work to be carried on continuously 24 hours per day.

Sand and gravel for the 20,000 yds. of concrete were

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[2] Lackawanna Steel Co., Buffalo, N. Y.
[3] Lawrence Pump and Engine Co., New York City.
[4] Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.
[5] Broderick and Bascom Rope Co., St. Louis, Mo.
[6] Lidgerwood Mfg. Co., New York City.
[7] Lambert Hoisting Engine Co., Newark, N. J.

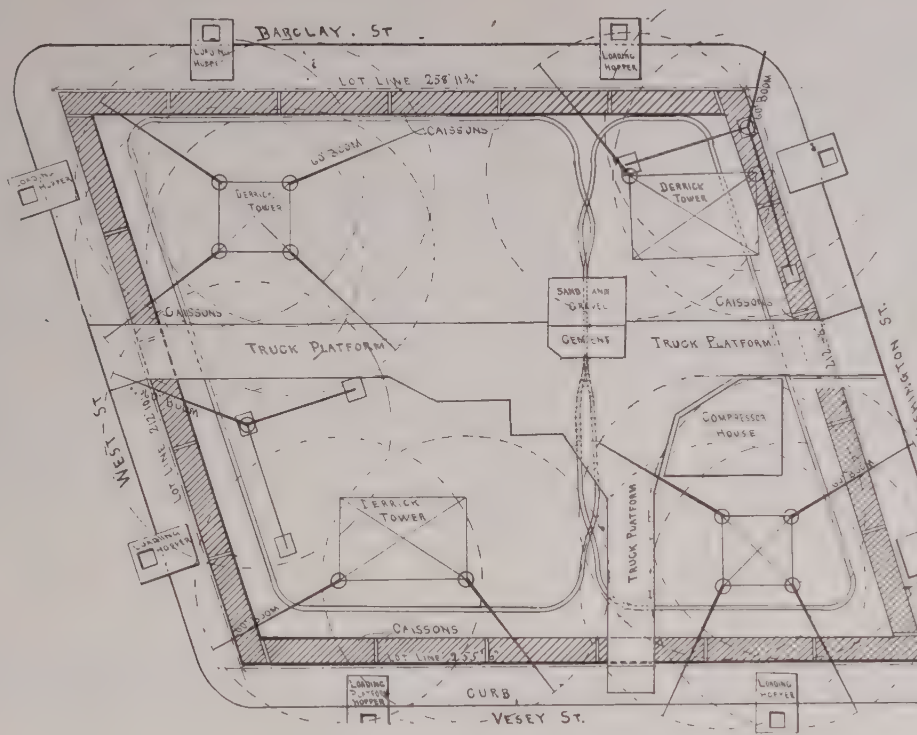

Fig. 3—Plan Showing Layout of Construction Equipment on Building Site

stored at the receiving yard and transported thence to the building as required by motor trucks that dumped into a steel-lined hopper.

Concrete Plant

The construction of the caisson wall enclosing the lots required about 20,000 yds. of concrete, all of the ingredients for which were delivered by the subcontractor's fleet of ten 5-ton motor trucks that provided the daily supply and maintained only emergency storage at the lots. The 23,000 yds. of pre-mixed aggregate, required for this and other concrete, consisted of clean sand and gravel supplied by the Rosoff Sand and Gravel Corp. It was stored in piles at the contractor's receiving yard and dumped at the lot into a steel-lined hopper below the track platform, and thence elevated by a bucket conveyor, driven by a 10-h.p. electric motor. The conveyors dumped into a 260-yd. storage bin that delivers through chutes to the batch-box hoppers on the mixing platform, below the level of the truck platform.

The aggregate and cement were dumped into the charging hoppers of two 1-yd Rex mixers,[8] driven by Westinghouse motors[4] and located below the mixing platforms, but just above and on opposite sides of a 24-in. industrial track, equipped with two 2-ton gasoline locomotives and seven flat cars. About 1500 ft. of track, laid with 16-lb. rails and 5-in. corrugated steel ties, formed a circuit around the entire lot, with spurs, sidings, by-passes, and switches necessary for the free circulation of the cars. Each car carried one 1-yd. bottom-dump bucket filled with concrete, that was unloaded by one of the sixteen derrick booms and dumped into the caisson forms, or into the cylindrical shaft buckets, and lowered to the working chambers.

The concrete was made with Atlas portland cement, of which 115,000 bags were required for the 20,000 yds. of concrete used in the caissons, that was mixed at a maximum rate of 12,000 yds. in eight hours by a force of 12 men.

The contractors provided a receiving yard, located on the bulkhead between Piers 46 and 47, North River, about a mile from the Telephone building, where cement, aggregate, and other supplies are received from boats, stored if necessary, and loaded on trucks, transferring them to the building site. It was also used as a disposal dock, the excavated material hauled there by motor trucks, unloaded into muck pans, and transferred to dock and bottom-dump scows which were towed to sea and dumped.

In this yard there are installed two stiff-leg derricks with 60-ft. booms, and one with a 40-ft. boom, all equipped with two- and three-drum Lidgerwood hoisting engines and swingers,[7] operated by steam from two Helser boilers. The derrick booms operate two 10-yd. steel skips, two ¾-yd. clamshell buckets, used for unloading aggregate, and two 1-yd. steel tipping buckets.

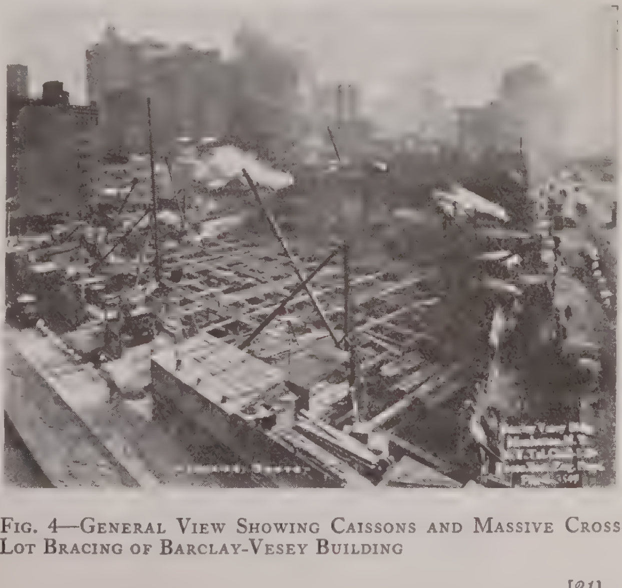

Fig. 4—General View Showing Caissons and Massive Cross-Lot Bracing of Barclay-Vesey Building

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[8] Chain Belt Co., Milwaukee, Wis.

The tipping buckets are loaded on the barges with 30 bags of cement, which they dump into the trucks that carry 150 to 180 bags per load, and make six round trips to the Telephone Building in one 8-hr. day. It generally takes two 8-hr. days to unload one barge. Sand and gravel are unloaded from the barges to storage piles or to loading hoppers, from which they are delivered to the trucks and transported to the building. This can be unloaded and stored or delivered to trucks at the rate of 400 yds. in 8 hrs.

Compressor Plant

A battery consisting of six air compressors of McKiernan Terry and other makes, having a total combined capacity of 8600 cu. ft. per min. at 60 lb. per sq. in. pressure and 1700 ft. more at 100 lb. per sq. in., furnished air for the pneumatic caissons and for pneumatic tools. The compressors, as well as the hoisting and swinging engines and pumps were operated by steam purchased from commercial mains in the street.

The high-prsesure air was delivered to a single receiver, and thence distributed through a single 2-in. main to the different caissons and to other points in the yard, where outlets were provided for connections to different tools. The low-pressure air was delivered through two large cross-connected receivers, and thence distributed around the lot to the caissons through a 4-in. main with 2-in. outlets.

Besides the equipment already mentioned, there was installed at the building one bag-shaker, a sack-baler, a drill sharpener, four electric motors of 5 to 20 h.p., one 10- and one 20-h.p. Westinghouse motor, one 8- x 20-ft. hospital lock, two hospital shanties, 20 air locks, one hundred 10-ft. sections of collapsible 36- x 60-in. steel shafts, and about 1,000,000 ft. of timber furnished by the John C. Orr Co.

McKenzie, Voorhees & Gmelin are the architects, Moran, Maurice & Proctor are the consulting engineers, Marc Eidlitz & Sons are the general contractors, and the Foundation Co. is the contractor for the substructure.

Impact Tests on Concrete Pavement Slabs

From a paper published in full in *Public Roads*, by Leslie W. Teller, Assistant Testing Engineer, U. S. Bureau of Public Roads.

Continuing the study of the magnitude and effect of motor truck impact begun four years ago, the Bureau of Public Roads has recently completed a series of tests to determine the resistance of pavement slabs of various designs to impact of motor vehicles. Previous reports dealing with earlier phases of the investigation have announced the findings of the bureau with respect to the possible magnitude of the impact forces resulting from the operation of trucks over road surfaces of different degrees of roughness, the relative strength of such forces compared with the static weight of the vehicle, the effect of differences in tire and spring equipment and variations in sprung and unsprung load upon the character and intensity of the impact, and the effect of the impact upon a limited number of specially constructed slabs of various designs.[1]

This report deals with the results of the tests of a second series of slabs more comprehensive in its range of types. As in the case of the previous reports, this one deals with only one phase of the investigation, which is being continued. The results reported are not entirely conclusive. They are to be regarded as sign boards which point the way rather than as a guaranty of safe arrival at the destination. If viewed thus broadly, it is felt that their publication will accomplish a useful purpose.

Some of the results are erratic, and in the absence of check tests can not be explained, but in the main they are quite consistent. Some of the indications are apparent throughout the tests, while others do not show so clearly in the data, and in such cases careful observations made in the course of the tests and the knowledge of the investigators as to conditions which influenced the results of individual tests have been drawn upon, as well as the recorded test data in forming the conclusions which are presented below.

Conclusions Drawn From the Tests

The exact nature of the tests must be borne in mind in applying the conclusions drawn from them to other conditions. The conclusions are stated in terms of maximum impacts delivered by the different weights of motor truck. Failure is assumed to have occurred when cracking takes place. The maximum impact values are such as would be expected under conditions of high speed and rough surface. Smoothness of the surface and suitable tire equipment will reduce the maximum impact pressures, with a resulting higher load carrying capacity than that indicated by the tests.

The essential features of the tests involve:

(1) Specimens 7 ft. square laid on a moderately plastic clay subgrade, the wet portion having water standing almost level with the surface, the dry portion being merely damp with capillary moisture.

(2) Repeated impacts increasing to the maximum, which caused cracking applied at the corner and at the center of one edge by an impact machine dealing blows closely resembling impact of motor trucks. Rolling loads were not applied. No impacts were delivered at the centers of the slabs.

The conclusions drawn from the test are as follows:

The resistance of the road slab depends in part upon the supporting value of the subgrade. A subgrade of high supporting value materially increases the resistance to impact.

Impact resistance of rigid slabs varies neither directly as the depth of the slab nor as the square of the depth, but as some power less than two.

In general, plain concrete slabs show no more resistance to impact delivered at the edge than to impact delivered at a corner.

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[1] Previous reports on these investigations will be found in several issues of *Public Roads*, as follows: Vol. 3, No. 35, March, 1921; Vol. 4, No. 6, October, 1921; Vol. 4, No. 7, November, 1921; and Vol. 4, No. 8, December, 1921.

Transverse cracks and longitudinal cracks near the sides of a road slab may be caused by impact delivered at the edge of the slab.

Plain concrete of 1:3:6 mix offers resistance to impact, ranging from about 60% to 80% of the resistance of plain concrete of 1:1½:3 mix. The lean mix also shows more variation in strength.

Reinforcing steel in concrete slabs, if present in sufficient amount and so placed as to receive tensile stress, adds to the resistance of the slab to impact.

Reinforcing steel placed longitudinally and transversely in equal percentages is more effective in preventing corner failures than the same amount placed in one direction.

For a given percentage of steel, small deformed rods closely spaced seem to be more effective than large deformed rods widely spaced.

There is very little evidence of cushioning by bituminous tops on concrete bases at temperatures of 90° F. or less.

In these tests, there was no evidence that bituminous tops on concrete bases added to the slab strength of the base, with the possible exception of the 4-in. and 6-in. bases on the dry subgrade.

Laid on the wet plastic subgrade none of the unreinforced slabs was capable of resisting impact at the edge or corner equivalent to that of a 5-ton truck; only the 8-in., 1:1½:3 slabs and the 2-in. Topeka tops on 8-in., 1:1½:3 bases resisted edge or corner impact equivalent to that of a 3-ton truck; all unreinforced slabs of lesser thickness failed under edge or corner impact less than that of a 2-ton truck.

Laid on a dry subgrade, the 8-in. plain concrete slabs of 1:1½:3 mix and the 8-in. edge thickness, unreinforced, 1:1½:3 bases with 2-in. Topeka tops resisted edge and corner impact equivalent to that of a 5-ton truck with a safe margin; no other slabs were capable of resisting the 5-ton truck impact even under the favorable conditions of dry subgrade support. A section of 6-in. plain concrete base, 1:1½:3 mix, with a 2-in. Topeka top, resisted the edge impact of a 3-ton truck; no other slabs of lesser edge thickness, laid on the dry subgrade, were capable of resisting impact greater than that of a 2-ton truck.

None of the systems of steel reinforcing tested added sufficiently to the strength of a 6-in. 1:1½:3 concrete slab to enable it to resist the edge and corner impact of a 3-ton truck when the slab was supported by a very wet, plastic subgrade, nor to resist the edge or corner impact of a 5-ton truck when the slab was supported by a dry subgrade.

In some of the tests there was evidence that, while the presence of the steel did not assist greatly in preventing the formation of the first crack, it did prevent the development of the crack and the further failure of the slab.

Object and Order of the Tests

The object of this series of tests which, like the other series, was conducted at the Arlington Experimental Farm, Arlington, Va., was to secure data on the comparative resistance of sections of various types of road slabs when subjected to impact forces of the same magnitude as those applied to actual roads by modern truck traffic of different weights.

To carry out this purpose, three distinct steps were required, as follows:

1. The determination of the magnitude of the maximum impact to which a road slab is subjected by motor trucks of different sizes.
2. The application of similar impact forces to the test sections.
3. The measurement of the effect of these impacts on the various test sections.

In order to carry out the first step in the program, a series of about 100 road tests was run to determine the maximum impact to which a road slab is subjected when different sizes of motor trucks are driven over it, fully loaded and at their maximum speed.

At the present time, the Bureau of Public Roads is conducting a similar but much more elaborate series of tests to determine this and other information regarding actual motor truck impact. But for the purpose of the impact tests on pavement slabs, the tests were limited to standard types of 2-ton, 3-ton, and 5-ton trucks. Standard equipment in the way of solid tires, wheels, springs, and spring suspension was used. These trucks were driven over typical concrete roads, maintained in good condition, and the maximum rear wheel impact was measured by means of an especially designed accelerometer.

Description of the Test Sections

As in the first series of impact tests, the attempt was made to reproduce two subgrade conditions—a dry, well-drained type and a thoroughly saturated one. Extra precautions were taken to insure as much contrast as possible between the bearing values of the two subgrades.

One hundred and twenty-four slabs were laid, embracing in all about 40 different types. Each slab was laid in duplicate, and the more important types were placed on both the dry and the wet subgrades. All slabs were 7 ft. square.

The types of slabs may be roughly divided into five groups:

1. Plain concrete
2. Reinforced concrete
3. Concrete bases and bituminous tops
4. Bituminous bases and bituminous tops
5. Macadam bases and bituminous tops

Tests of the slabs of all five groups have been completed, but this report does not deal with the tests of bituminous tops on macadam and bituminous bases. The behavior of these slabs is materially different from that of the concrete slabs and the concrete bases with bituminous tops, and it is felt that the results of the tests of these groups should receive further study before they are announced.

Plumbing Requirements

A final report of the sub-committee on plumbing of the Building Code Committee has been issued by the Bureau of Standards, and contains, in addition to the recommended plumbing code for adoption by city and state, an extensive report by the Bureau giving the procedure and results of experiments with plumbing systems carried on for over two years at the Institution. The report also presents a considerable amount of data and discussion interpreting the results of this experimental work in showing how the committee arrives at its recommendations for code revision.

The appendices describe recent developments in theory of corrosion of metals and investigations of the diffusion of gases in unventilated pipes.

A great part of the information developed by the Bureau of Standards investigation and most of the recommended code requirements apply to plumbing in large buildings as well as to that in dwellings. Considerable attention was given to methods predicting the loads on plumbing systems, and some data are given on conditions of use in large buildings. The report contains 250 pages of text and 100 illustrations, and is obtainable from the Government Printing Office, Washington, D. C., at 35¢ per copy.

Cost of Concrete Sewers in Hamilton, Ontario

A trunk system of sewers, comprising five sections of reinforced concrete and vitrified pipe, has recently been completed in Hamilton, Ont., after a thorough study of storm water run-off coefficients by the engineers, and the details of costs for different types of construction are an interesting feature in the description by H. S. Philips and W. M. Johnston in *The Canadian Engineer.*

The Homeside district is drained by a system of sewers, the design of which was based upon the run-off studies. The trunk system was divided into five main contracts. Section 1 is in Kenilworth Ave., 4900 ft. long, the contract being awarded to A. Cope & Son, Hamilton, on a unit price basis for $186,279.55. The work consisted of 20,270 cu. yds. of earth and rock excavation, all in open cut, 4140 cu. yds. of 1:2:4 concrete, 1685 cu. yds. of 1:3:5 concrete, 7765 lin. ft. of 12-in. vitrified pipe, and the placing of 130 tons of steel reinforcing, together with 25 manholes and junction chambers.

The typical cross sections of this sewer are shown in Figs. 2 to 6.

The earth and shale excavation was taken out entirely by Erie steam shovels, and loaded into wagons and immediately deposited on the completed sewer in the rear, the surplus being hauled to the low-lying land in the immediate vicinity of the work. Rock was drilled by air drills, blasted, loaded into skip buckets, and hoisted by means of a steam crane to wagons alongside the cut.

In concreting Section 1, the invert was poured first, 6 in. of the walls being poured with this operation to form a guide for the wall forms. This concrete was allowed to harden 48 hr. before the forms were placed. Collapsible Blaw-Knox steel forms were used throughout the entire length of this section. Forms were in 20-ft. sections, and were moved forward by telescoping slightly, the weight being taken by a car which operated on steel rails laid on the invert of the sewer. The sections were easily moved forward and jacked into place.

The aggregate used was either 1-in. broken stone or 1-in. water-washed screened gravel, the concrete being mixed in steam-driven London mixers and deposited by gravity. Where concreting operations were carried on in freezing weather, the materials were heated by covering the piles with tarpaulin and shooting live steam into them. The finished work was covered with tarpaulin, with a steam line placed above the concrete and under the covering. Frame doors were fitted to the inside of the sewer at each end of the pour, and salamanders placed inside as a further protection against freezing.

Piling was required where the line of the sewer crossed an inlet, a foundation being laid on five rows of piles, 4 ft. o. c., the bents being 6 ft. apart. The

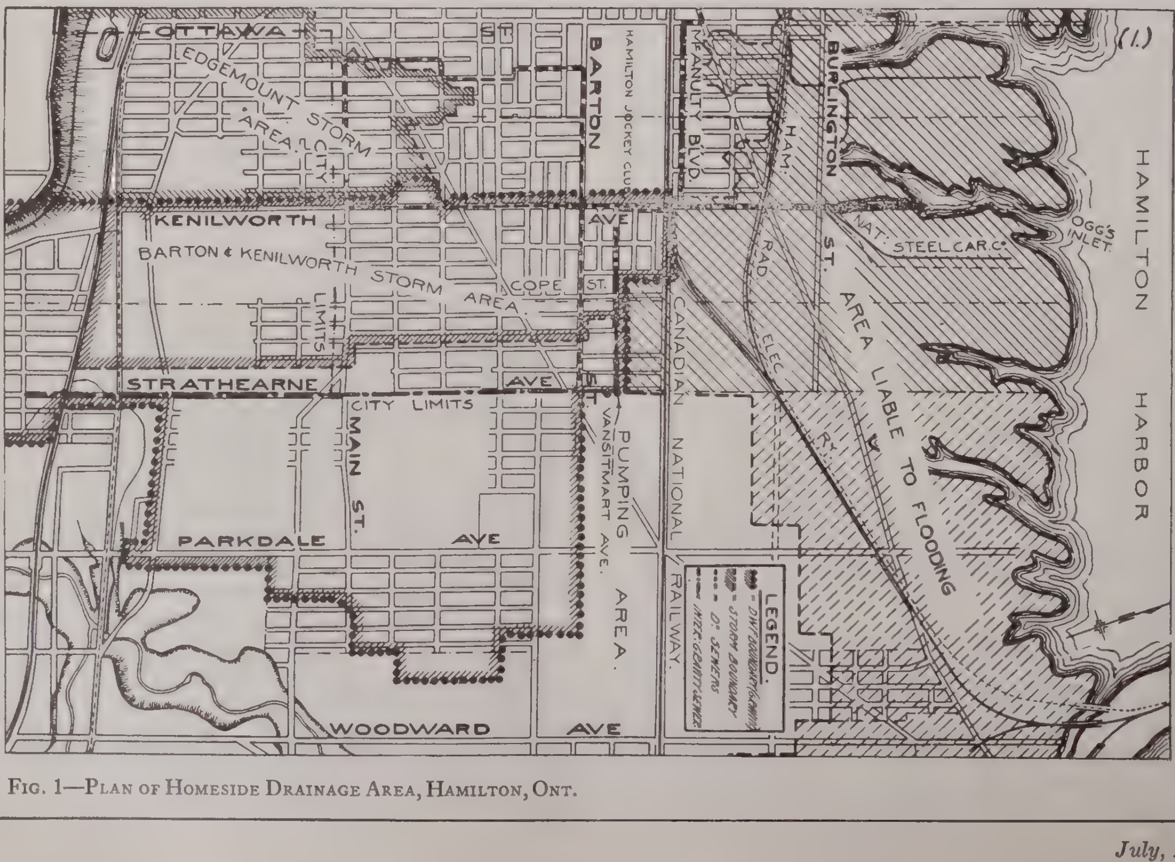
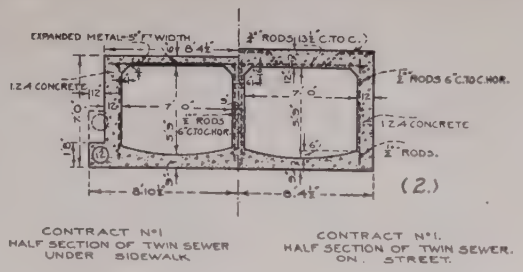


Fig. 1—Plan of Homeside Drainage Area, Hamilton, Ont.



CONTRACT N°1
HALF SECTION OF TWIN SEWER
UNDER SIDEWALK

CONTRACT N°1.
HALF SECTION OF TWIN SEWER.
ON STREET.

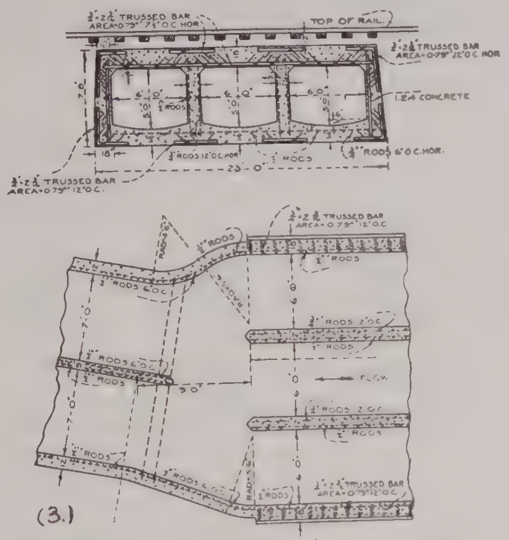

$\frac{3}{4}$"-2$\frac{1}{4}$" TRUSSED BAR AREA = 0.79" 7$\frac{1}{2}$" O.C. HOR.
TOP OF RAIL
$\frac{3}{4}$"-2$\frac{1}{4}$" TRUSSED BAR AREA = 0.79" 12" O.C. HOR.
1.2.4 CONCRETE
6' 0"
6' 0"
6' 0"
18"
$\frac{3}{4}$" RODS 12" O.C. HOR.
$\frac{1}{2}$" RODS
$\frac{3}{4}$" RODS 6" O.C. HOR.
23' 0"
$\frac{3}{4}$"-2$\frac{1}{4}$" TRUSSED BAR AREA = 0.79" 12" O.C.
$\frac{3}{4}$" RODS
$\frac{1}{2}$" RODS
$\frac{1}{2}$" RODS 6" O.C.
$\frac{1}{2}$" RODS 2' O.C.
FLOW
9' 0"
(3.)

Fig. 2—Half Sections of Twin Sewer, Contract No. 1

Fig. 3—Contract No. 1—Details of Triple Section under Siding to National Steel Car Plant

piles were driven with a steam hammer to an average depth of about 20 ft.

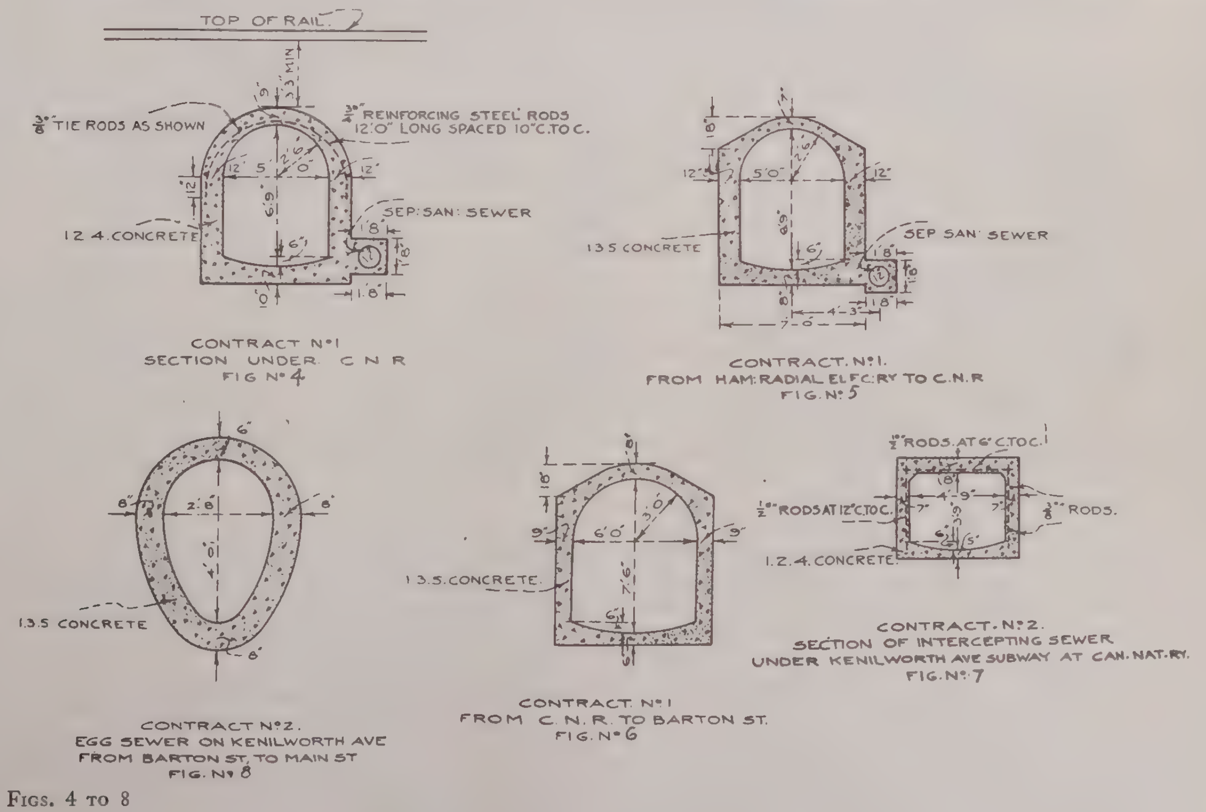
Table No. 1 shows the cost of construction of the twin section at the outlet, 5 ft. 9 in. x 7 ft.

Section No. 2 is 6075 ft., extending from McAnulty Blvd. to Main St. in Kenilworth Ave., contract having been awarded to McLaughlin Bros., Ottawa, on a unit price basis for $98,649.90. This work was all done in open cut, and included 13,300 cu. yds. of earth and rock excavation, 1765 cu. yds. of 1:3:5: concrete, 1280 lin. ft. of 12-in. vitrified pipe, 555 lin. ft. of 24-in. vitrified pipe, and 14 manholes.

Earth was excavated with a Parsons excavator, which elevated it directly into wagons from which it was dumped either into the excavation over the completed sewer in the rear, or hauled away. The rock was drilled by air drills, and blasted, loaded into skip buckets, hoisted, and carried back to the completed section of the sewer by means of a Moore trench machine. The sides and bottom of the trench were then trimmed to the outside lines of the sewer with a pneumatic concrete breaker, which was found to work very satisfactorily with a small percentage of overbreak.

Wood forms covered with galvanized sheet metal were used on this section. Care was taken to keep these forms well cleaned and oiled after each pour. Concreting operations were divided into two pours, first the invert was poured up to the springing line, and the concrete allowed to harden 48 hours before the arch forms were set. Work was carried on continuously from start to finish, the contract calling for the work to be completed in 8 months. Table 2 shows the actual construction cost of the egg-shaped section of the sewer. Typical cross sections are shown in Figs. 8 and 9.

Section No. 4 was built by relief labor by the city engineer's department, the only machinery used being a small gasoline-driven air compressor for drilling the rock, and a concrete mixer. This section is 3310 ft. long, and consisted of 39-in. and 42-in. circular mono-



CONTRACT N°1
SECTION UNDER C N R
FIG N°4

CONTRACT. N°1.
FROM HAM: RADIAL ELEC: RY TO C.N.R
FIG. N°5

CONTRACT N°2.
EGG SEWER ON KENILWORTH AVE
FROM BARTON ST. TO MAIN ST
FIG. N°8

CONTRACT N°1
FROM C. N. R. TO BARTON ST.
FIG. N°6

CONTRACT. N°2.
SECTION OF INTERCEPTING SEWER
UNDER KENILWORTH AVE SUBWAY AT CAN. NAT. RY.
FIG. N°7

Figs. 4 to 8

Table No. 1—5 ft. 9 in. x 7 ft. 0 in. Reinforced Concrete Twin Sewer at Outlet—Sec. No. 1—Homeside

Acct. Number	Account Name	Quantities	Rental	Unit Rental Cost	Labor	Unit Labor Cost	Material	Unit Mat. Cost	Total	Total Unit Cost
1-1-01	Engineering and Inspection............				$1,155.89				$1,155.89	4%
1-1-02	Excavation—Clay.....................	3,114 c.y.	$377.50	$0.16	1,122,06	$0.36	$124.15	$0.04	1,623.71	$0.56
1-1-03	Backfill..............................	650 c.y.	40.00	.06	251.36	.39	11.70	.02	303.06	.47
1-1-04	Surplus..............................	1,000 c.y.	82.50	.08	535.92	.54	34.90	.03	653.32	.65
1-1-05	Forms................................	38,665 s.f.	30.00		1,278.20	.03	1,524.00	.04	2,832.20	.07
1-1-06	Reinforcing Bars.....................	813.2 cwt.			193.50	.24	2,030.09	2.50	2,223.59	2.73
	Mesh.................................	204.9 cwt.			68.50	.33	1,567.12	7.65	1,635.62	7.98
1-1-07	Conc. Inv. Cl. "A"...................	602 c.y.	344.00	.57	1,426.25	2.37	5,330.21	8.86	7,100.46	11.80
1-1-08	Conc. Walls and Slab Cl. "A".........	1,046 c.y.	468.00	.45	2,053.47	1.96	8,723.17	8.34	11,244.64	10.75
1-1-09	Finishing Concrete...................	44,323 s.f.	10.00		509.87	.01	130.25		650.12	.015
1-1-10	Heating Materials....................	470 c.y.	211.00	.45	324.75	.69	120.20	.25	655.95	1.39
1-1-11	Cleaning Sewer.......................	563 ft.			301.75	.53			301.75	.53
1-1-12	Sundries and Watching................				1,346.68				1,346.68	4½%
1-1-13	Overhead—10%.........................		156.30		1,056.82		1,959.58		3,172.70	10%
	Total......................... ..	563 ft.	1,719.30	$3.05	$11,625.02	$20.65	$21,555.37	$38.29	$34,899.69	$61.99

Table No. 2—2 ft. 8 in. x 4 ft. 0 in. Concrete Egg Shaped Sewer in Open Cut—Homeside

Acct. Number	Account Name	Quantities	Rental	Unit Rental Cost	Labor	Unit Labor Cost	Material	Unit Mat. Cost	Total	Total Unit Cost
2-7-01	Engineering and Inspection............				$ 564.91				$ 564.91	
-02	Excavation—Rock......................	3,884 c.y.	$2,084.00	$0.54	8,845.82	$2.28	$2,526.51	$0.65	13,456.33	$3.47
	Excavation—Earth-Trencher............	3,679 c.y.	1,580.00	.43	2,046.21	.56	760.50	.21	4,386.71	1.20
-03	Removing Surplus.....................	2,290 c.y.			2,009.25	.90			2,009.25	.90
-04	Backfill..............................	5,273 c.y.	645.00	.12	2,493.62	.47	201.50	.04	3,340.12	.63
-05	Forms................................	320 c.s.f.			1,228.25	3.84			1,228.25	3.84
-06	Concrete..............................	1,074 c.y.	990.00	.92	3,421.00	3.18	9,385.46	8.74	13,796.46	12.84
-07	Finishing Concrete...................	3,277 l.f.			128.50	.04			128.50	.04
-08	Pumping and Timbering................	3,277 l.f.	410.00	.13	549.50	.17			959.50	.30
-09	Moving and Erecting Plant............	3,277 l.f.			1,628.62	.50			1,628.62	.50
-10	Sundries and Watching................	3,277 l.f.			1,187.18	.36			1,187.18	.36
-11	Cleaning Sewer.......................	3,277 l.f.			98.00	.03			98.00	.03
-12	Overhead—10%.........................		570.90		2,420.08		1,287.40		4,278.38	
	Total................................	3,277 l.f.	$6,279.90	$1.91	$26,620.94	$8.12	$14,161.37	$4.32	$47.062.21	$14.35

Table No. 3—39 in. Circular Monolithic Concrete Sewer—Homeside

Acct. Number	Account Name	Quantity	.Labor	Unit Labor Cost	Material	Unit Mat. Cost	Total	Total Unit Cost
4-3-01	Earth Excavation.....................	1,843 c.y.	$ 4,456.23	$ 2.43			$ 4,456.23	$ 2.43
-02	Rock Excavation......................	798 c.y.	2,937.12	3.68	$ 402.58	$ .51	3,339.70	4.19
-03	Timbering............................	1,062 ft.	431.16	.41	108.85	.10	540.01	.51
-04	Pumping..............................	1,062 ft.	669.66	.63			669.66	.63
-05	Backfill and Surplus.................	2,641 c.y.	2,197.85	.83			2,197.85	.83
-06	Forms and Setting....................	121 c.s.f.	310.25	2.55	223.02	1.84	533.27	4.39
-07	1-3-5 Concrete.......................	270 c.y.	654.13	2.42	2,104.66	7.80	2,758.79	10.22
-08	Finishing Concrete...................	121 c.f.s.	150.16	1.24	34.23	.28	184.39	1.52
-09	Manholes.............................	44 ft.	69.72	1.58	458.36	10.42	528.08	12.00
-10	Sundries, Watchman, etc..............	1.062 l.f.	491.27	.46	24.55	.02	515.82	.48
-11	Overhead—10%.........................		1,236.75		335.63		1,572.38	
	Total................................	1,062 l.f.	$13,604.30	$12.81	$3,691.88	$3.48	$17,296.18	$16.29

Table No. 4—4 ft. 6 in. x 5 ft. 3 in. Monolithic Concrete Sewer in Rock Tunnel—Homeside

Acct. Number	Account Name	Quantity	Labor	Unit Labor Cost	Material	Unit Mat. Cost	Total	Total Unit Cost
5-1-01	Superintendence and Timekeeper........		$ 1,815.59				$ 1,815.59	5%
-02	Sinking Shafts.......................	44 ft.	610.34	13.87	$ 443.33	$10.08	1,053.67	23.95
-03	Mining, Mucking and Hoisting..........	1,211 ft.	9,833.29	8.12	2,080.48	1.72	11,913.77	9.84
-04	Removing Surplus.....................	1,340 c.y.	1,650.00	1.23			1,650.00	1.23
-05	Forms and Setting....................	1,211 ft.	1,432.73	1.18	1,234.54	1.02	2,667.27	2.20
-06	Conc. Walls and Crown................	1,202 ft.	2,289.39	1.90	4,212.54	3.51	6,501.93	5.41
-07	Conc. Invert..........................	1,230 ft.	1,192.33	.97	1,380.94	1.12	2,573.27	2.09
-08	Finishing Concrete...................	196 c.s.f.	558.58	2.85	87.20	.44	645.78	3.29
-09	Plant.................................		1,996.87		840.65		2,837.52	
-10	Manholes and Drop Shaft..............	44 ft.	409.23	9.30	341.29	7.75	750.52	17.05
-11	Regulating Chamber and Manhole.......		992.04		241.77		1,163.81	
-12	Regulating Valve.....................				381.43		381.43	
-13	24-in. V.P. Connection...............	22 ft.	36.00	1.64	166.83	7.58	202.83	9.22
-14	15-in. V.P. Connection...............	23 ft.	137.50	5.93	61.70	2.68	199.20	8.61
-15	Watching, Fencing and Lighting........	1,211 ft.	525.01	.43			525.01	.43
-16	Pumping..............................	1,211 ft.	459.10	.38			459.10	.38
-17	Sundries..............................	1,211 ft.	832.05	.69	34.73	.03	866.78	.72
-18	Overhead..............................		1,235.00				1,235.00	
	Total................................	1,211 ft.	$25,935.05	$21.41	$11,507.43	$9.50	$37,442.48	$30.91

NOTE—Sinking shafts, covers, excavating shaft 8 ft. x 8 ft., removing surplus and timbering. Plant, covers, moving to job, erecting, dismantling and repairing; regulating chamber and manhole includes excavation. See detail, Fig. 10.
Excavation per lin. ft. in tunnel equals 1.10 cu. yd.
Concrete in walls and crown, per lin. ft. equals .305 cu. yd.
Concrete in invert, per lin. ft. equals .12 cu. yd.

lithic concrete, in Cope St. from Barton St. to Main St. The work included 2000 cu. yds. of rock excavation, 5450 cu. yds. of hard clay excavation, and 860 cu. yds. of 1:3:5 concrete. Wood forms covered with galvanized sheet metal were used, the invert forms being in 10-ft. lengths and the arch forms in 5-ft. lengths. These sections were made semi-collapsible, so that they could be drawn through the sewer with ease. The construction cost of this work was $52,203.

Table 3 gives cost data for the 39-in circular section.

Section No. 5, on Barton St., is 2637 ft. long. This includes 1230 lin ft. of 4 ft. 6 in. by 5 ft. 3 in. monolithic concrete sewer in rock tunnel, 256 lin. ft. of 42-in. reinforced concrete pipe, and 252 lin. ft. of 36-in. reinforced concrete pipe. The remainder was made up of vitrified pipe.

The tunnel section was built by mining in four headings, each approximately 300 ft. long. Mining operations consisted of drilling 3-ft. holes into the face of the rock with air drills and loading them with 40% polar forcite, discharged by direct contact with the electric lighting system. Steel plates placed on the

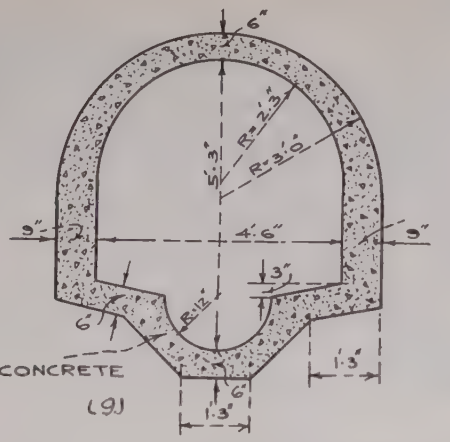


Fig. 9—Contract No. 5—Barton St. Sewer. Section in Tunnel

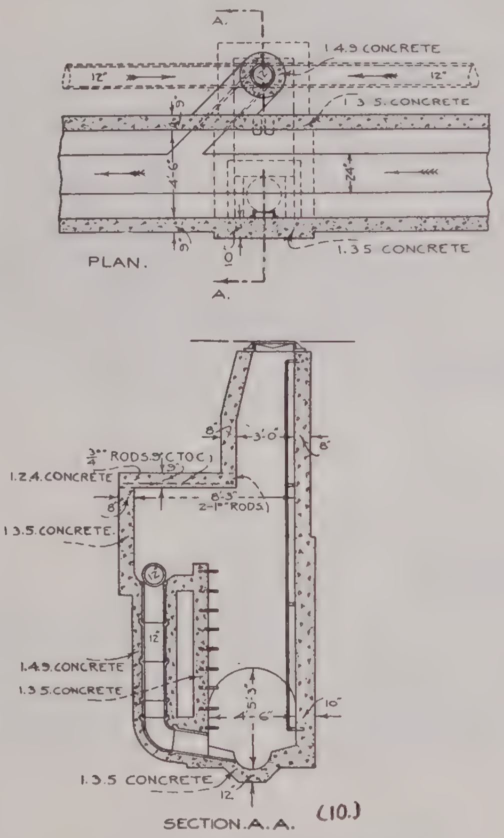


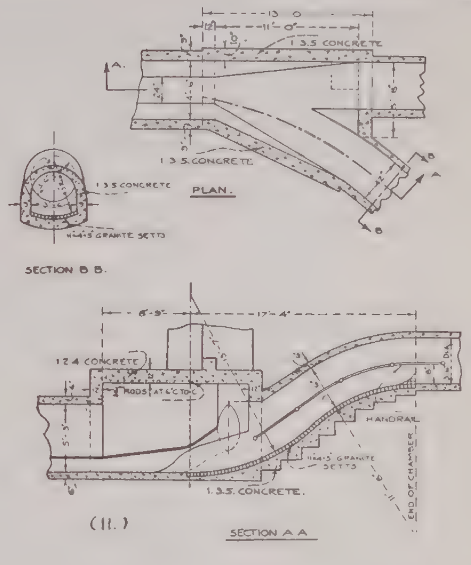
Fig. 10—Typical Manhole and Drop Shaft

floor of the tunnel directly in front of the face facilitated the shoveling of the rock into the buckets. The fumes from the explosives were driven from the tunnel by an effective installation, consisting of pet cocks on the air line along the side of the tunnel, pointing diagonally backward toward the shaft, and one at the bottom of the shaft, pointing upward. After a charge was fired, the air was turned on and the fumes forced to the shaft and out, clearing the heading in a very few minutes. The mining was done by two miners, and the rest of the organization consisted of one mucker in each heading, a signal man, an engineer, and one team for each shaft. A compressor operator and a foreman operated for two shafts, or four headings. The average daily shift in each heading was 5 ft. in 9 hours.

A separate concreting gang, composed of a foreman, an engineer, and 7 laborers, worked the night shift, pouring 20 ft. of sewer in 8 hrs., 10 ft. in each heading, and working alternating shifts each night. The walls and crown were poured in the first operation, using Blaw-Knox steel forms, and the invert was poured after the whole tunnel was completed.

The remainder of the work was done in open cut. A trench machine hoisted the buckets out of the trench, depositing the excavated material on the completed sewer. This machine was also used for lowering and placing the larger sizes of pipe in the bottom of the trench. The total cost of this section was $64,082.

Table 4 gives unit costs for the 4 ft. 6 in. by 5 ft. 3 in. monolithic concrete sewer in rock tunnel. Fig. 9 shows a typical cross section.



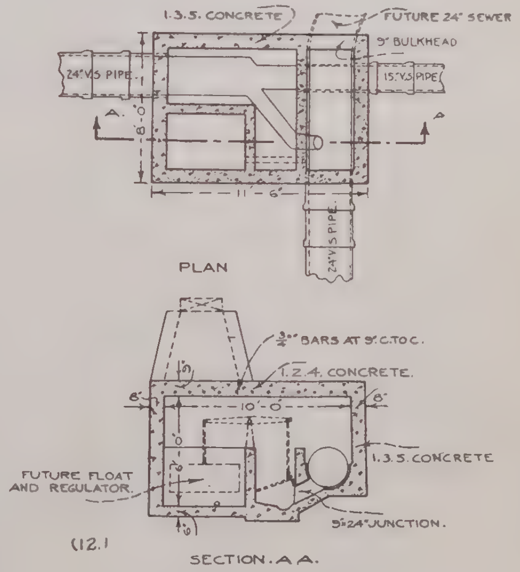


Fig. 11—Contract No. 5—Details of Junction Chamber, Barton St., and Cope St.

Fig. 12—Contract No. 5—Details of Manhole at Barton St., and Fairfield Ave.

The Semi-Annual Index to Concrete, Vol. 24, January to June 1924, is ready for distribution to those subscribers who ask for it.

Reducing the Cost of Concrete Bulkheads

By Taggart Aston
Consulting Engineer, M. Soc. Term. Engrs.

In architectural works much money is apparently wasted upon aesthetic and superfluous elements, and custom has permitted architects to use considerable latitude in this respect. In engineering, however, safety and economy are guiding principles, and to combine the two to the best advantage requires that ingenuity and careful thought which are the recognized attributes of the engineer, who is usually desirous in his clients' and the public interest of seeking the best and most economical types of design.

In some types of engineering structures, improved materials and new methods have considerably cheapened their construction and added to their utility. In permanent types of bulkheads for use as retaining walls, dock walls, bridge abutments, and dam walls, the use of modern materials has not, however, evolved new types which make for marked economy, except, perhaps, in certain types of dam walls.

To attempt to accomplish this desired end by any radical change in design is, therefore, to invoke either the wrath or commendation of those qualified to judge; and any radical departures from the conventional is either quickly condemned or eagerly seized upon by those seeking cheaper or improved methods.

The interest and spirit of kindly encouragement shown by prominent engineers, both in Europe and America, have led the writer to endeavor to develop the hollow stepped-down concrete wall for use as a bulkhead for wharves, retaining walls, and the like.

Generally accepted standards of permanent bulkhead types might be grouped as follows:

(1) Solid gravity walls of masonry or concrete. The latter sometimes having a slight reinforcement at the back.

(2) Crib walls of reinforced concrete stretchers at front and back, interlocked by occasional headers.

(3) A reinforced concrete type of thin section vertical wall with a thick, wide base. Commonly called the "cantilever" wall.

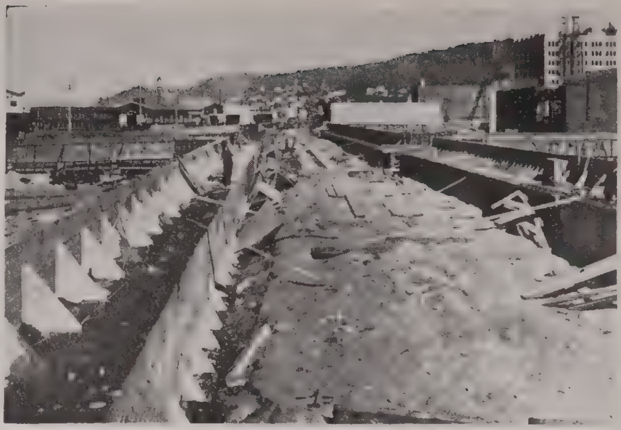
(4) A reinforced concrete type with a thin vertical wall strengthened by counterforts or buttresses and resting upon a thick, wide base. Commonly called the "counterfort" retaining wall.

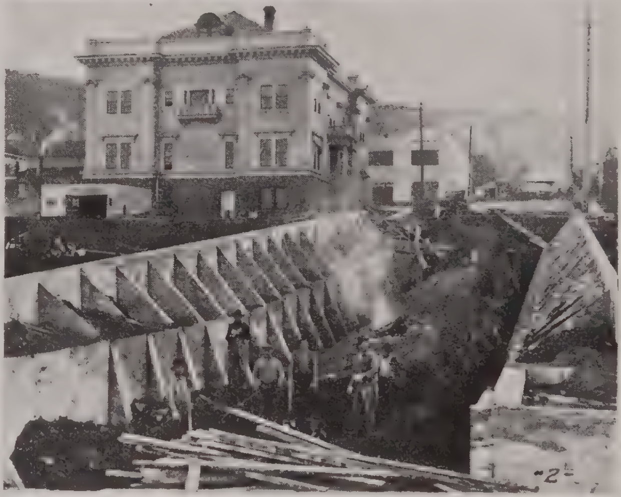
(5) A reinforced concrete cellular or webbed wall resting upon a thick, spreading base.

From estimates or actual costs of numerous designs and examples, the average comparative costs of these different types would come in the following order—assuming a wall 20 ft. 6 in. high, and using the same unit costs for material and labor:

No. 5—$68 per lin. ft. of wall
No. 1—$62 per lin. ft. of wall
No. 4—$54 per lin. ft. of wall
No. 3—$51 per lin. ft. of wall
No. 2—$46 per lin. ft. of wall

In the step wall type, a wall of the same height as the example above and of analogous stability would cost $38 per lin. ft. The saving in cost would increase, in comparison with the cantilever type, approximately as the square of the height.





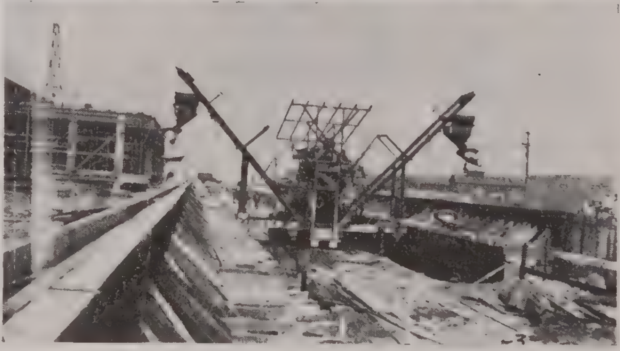


Fig. 1—Part of 10,000 Lin. ft. of Aston Step Wall Built at Astoria, Ore. in 1923

Fig. 2—Aston Step Walls Ranging from 15 ft. to 21 ft. in Height at Astoria, Ore.

Fig. 3—Mixer Used by John Slotte & Co., Contractors, for Pouring Concrete in Step Walls on Both Sides of Street at One Time

It will be of interest to compare the alternative quantities per lineal foot of 12 ft. high walls upon which bids were taken at Astoria, Oregon, in April, 1923:

Aston Step Wall	Standard (Cantilever) Wall
0.17 cu. yds. excavation in founds.	0.50 cu. yds. excavation in founds.
0.545 cu. yds. concrete	0.81 cu. yds. concrete
49 lbs. steel reinforcement	59 lbs. steel reinforcement
34 sq. ft. formwork	28 sq. ft. formwork
5.88 lin. ft. piling	7.51 lin. ft. piling

The step wall type was chosen, and some 10,000 lin. ft. of retaining wall was built up to the end of 1923. The above quantities are slightly greater than those in an ordinary step retaining wall, as a wider step than was necessary for bulkheading purposes was used, in order to provide open space for water pipe and electrical wires underneath the step. In a step wall 21 ft. high, built at Astoria, the quantities show a saving of $15.50 in cost per lin. ft. in favor of the step wall under the cheapest form of standard type wall.

The city of Astoria, Oregon, was destroyed by a fire

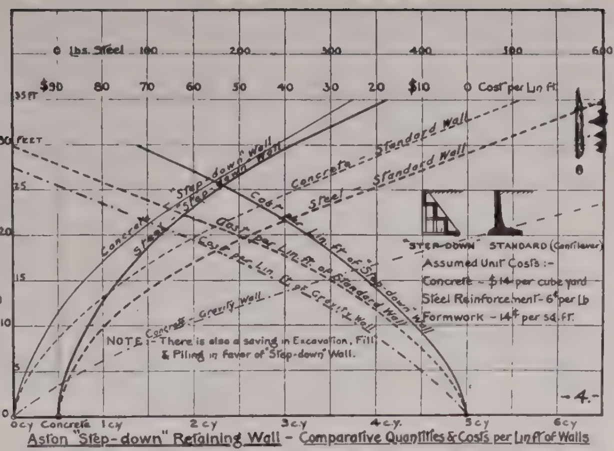


FIG. 4—DIAGRAM SHOWING COMPARATIVE QUANTITIES OF MATERIAL AND COST PER LIN FT. OF WALL

in December, 1922, and is rapidly being rebuilt of reinforced concrete buildings. The building in the background of Fig. 2 is the city hall which escaped damage by fire, although practically all the rest of the business district was destroyed. Fig. 2 shows sections of the wall built on a slope at Astoria and ranging from 13 to 21 ft. in height. The spans between supporting columns on the outer side of walls are 15 ft. and counterfort are 7 ft. 6 in. apart from center to center. The Astoria work was carried out under the supervision of R. A. McClanathan, city engineer, the contractors were John Slotte & Co., and the preliminary plans were supplied by the Aston Step Wall Co., Portland.

From a knowledge of step walls, as constructed, and from a study of numerous designs and careful comparisons made with all known types of standard walls, it is believed that the use of the new and radical methods of design in the step walls makes them the cheapest and most stable form of permanent bulkhead yet developed.

Among the main advantages claimed for the step wall system are:

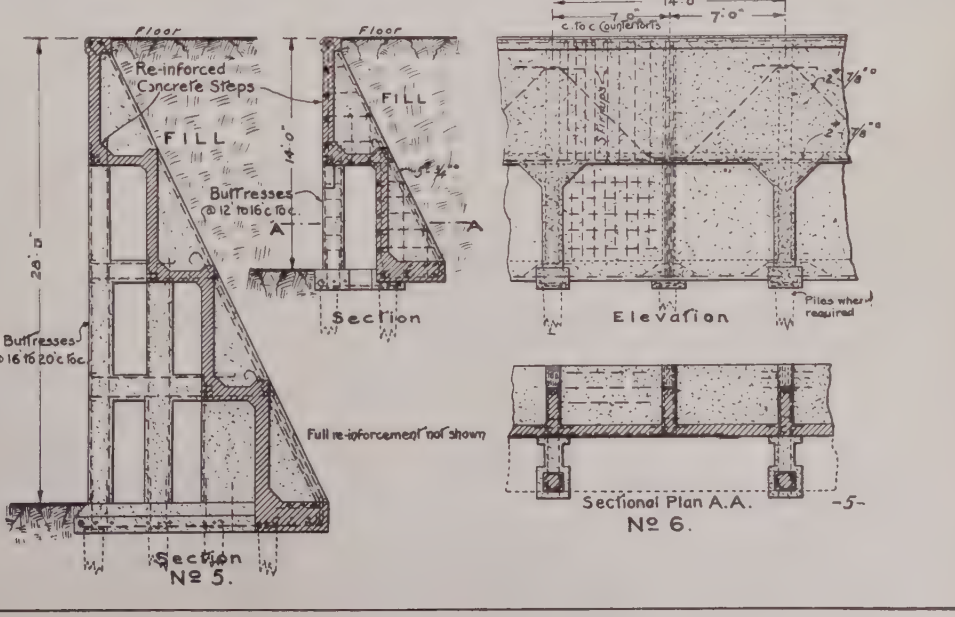
Economy. The series of small step-down retaining walls, supported on columns or bents, contain much smaller quantities of steel or concrete than do standard gravity, cantilever, or counterforted walls of the same heights. It has also been found that in the step wall there is a lesser amount of fill, excavation, and piling. In the comparative curves of cost (Fig. 4), the extra cost of timber formwork has been allowed for. The use of metal forms would reduce this item.

Stability. The stepping back and downward of the small counterforted retaining walls eliminate a large wedge of weight (existent in standard walls) in fill and concrete from the front of the step wall. Due to this lightening of weight in the front of the wall, the resultant force, tending to overturn, is thrown farther back in the step wall than in standard walls, thus making it more stable than the latter, assuming heights of wall and widths of base to be the same. The elimination of this large weight also materially reduces the amount of piling and underpinning required.

Precast Features. By using precast steps, bents, and columns in wharves subject to tidal action, the difficulty of molding concrete in place, except at joints, between tides can be dispensed with. Ordinary small step retaining walls can be precast in short lengths—using standardized metal forms—at a considerable reduction in cost. The weight of a wall 10 ft. high, 12 ft. long, would not exceed 7 tons. The columns and foundations would, preferably, be molded in place.

For Wharves. Several designs have recently been made for step wall wharves in Canada, Europe, and the United States. The engineer for the new mail steamer pier to be built at Queenstown, Ireland, has adopted the step wall system, after comparing it with standard types, and has estimated that it would save some $600,000 under the cost of the latter. The designs for its adapatation to wharves vary considerably and have to be specially considered with respect to the particular requirements at each site. It is the only type of permanent, fireproof wharf that approximates in first cost with—and is in some situations less in cost than—wharves built wholly of timber. John Kenlon, chief of New York Fire Department, has stated in his book on *Fires and Fire Fighting*, that "the sheds, or wharves, common to America, form about the most dangerous structures of their kind in existence. Built on wooden piles, with wooden superstructures, they are comparable to nothing but horizontal flues, through which the flames rush with lightning-like rapidity, rendering abortive *any efforts*

FIG. 5 — DETAILS OF TYPICAL ASTON STEP WALL ADAPTED FOR RETAINING WALL



on the part of the fire department." The advent of the economically adapted step wall wharf should, therefore, be received by port authorities as an economical substitute for the temporary, inflammable wharf structures now so generally used.

Investigations and designs made so far, show that the step wall system, as applied to dam walls, gives a cheaper construction than the standard types of dam walls. Some further research and study will have to be made with regard to its use in competition with these. It is possible that its use in combination with a sloped bank of puddle clay—to be placed against the stepped face of the dam—will offer a favored type of construction.

Test Wear of Concrete Pavements

Introduction and conclusions from a report by F. H. Jackson, Senior Assistant Testing Engineer, and J. T. Pauls, Highway Engineer, U. S. Bureau of Public Roads of accelerated tests by U. S. Bureau of Public Roads, in the Bureau's publication *Public Roads*.

The accelerated wear tests of concrete pavements conducted by the Bureau of Public Roads, at Arlington, Va., during the past 18 months, have reached the stage where it is possible to draw fairly definite conclusions from the data so far obtained. The 62 concrete test sections, each 4 ft. wide by about 10 ft. long, and constructed in the form of a circle approximately 625 ft. in circumference, have been subjected to approximately 300,000 passages of a solid-rubber-tired truck wheel loaded to 3000 lb. and traveling around the circle over the same path at a speed of 22 miles per hr. Careful observations of the lateral distribution of traffic across actual pavements indicate that about 10% of the total passes over a 6-in. width at the point of greatest concentration. This is based on traffic passing in two directions over an 18-ft. road. On this basis it is estimated that the experimental pavement sections have been subjected to a traffic equivalent to about 1,500,000 2-ton trucks operating at a speed of 22 miles per hr. assuming the distribution indicated by the above observations. In addition, the test sections have been subjected to about 50,000 passages of a rubber-tired wheel, loaded with the same weight and equipped with nonskid chains, and the same number of passages of a plain rubber-tired wheel. The wheels in this part of the test traveled over a new path. It will be seen, therefore, that the equivalent of an enormous volume of traffic has been put upon the pavement—an amount probably equivalent to several years' traffic on the average concrete road.

It was, of course, impossible to reproduce on the test sections in the short space of a year and a half the effect of freezing and thawing which, through a period of years, may weaken actual roads so that they become less resistant to traffic. It was likewise impossible to reproduce the effect of differential expansion and contraction of the thin, rich mortar top and the mass of the concrete, which, caused by wide variations in temperature, may also, in time, lower the resistance of a pavement. The essential time element is lacking. In these respects, therefore, the test did not duplicate actual conditions, and for this reason the differences in the behavior of the several sections under examination may not be so marked as they normally would have been.

The Purpose and Results of the Test

The primary object of the test was to determine what relations, if any, existed between the surface behavior of concrete roads under traffic and the various laboratory tests for quality of the aggregates. Incidentally it was also deemed desirable to determine the relation between the wear as produced by traffic, as well as by laboratory test, and the various physical properties of the concrete, such as crushing strength, transverse strength, modulus of elasticity and absorption. All of these tests were made on the concrete used in each of the 62 test sections.

Specifications for aggregates for concrete pavements are usually drawn to cover the gradation and the quality of the material furnished. The gradation, or proportion of the various sizes, especially as regards aggregates which are crushed and screened, depends largely on factors which can be controlled, so that the engineer may obtain almost any desired gradation of sizes, provided he is willing to insist upon it. The quality of the material, however, can not be fixed in so arbitrary a fashion. Due to the high cost of transportation, the aggregates for any given improvement must generally be found within a relatively short distance of the site of the work. Therefore, as the quality and character of materials varies so greatly in different parts of the country, it follows that many different kinds and types of aggregates must be employed in the construction of concrete roads. All that can be done is to draw specifications in such a way as to ensure the use of the best material available for the work. In so doing, however, there is always a minimum limit beyond which it is unsafe to go.

What are the safe test limits for the various kinds of aggregates used in concrete road construction? Do the present limits for wear, strength, etc., ensure the selection of safe materials, or, on the other hand, do they unduly add to the cost of construction by setting laboratory requirements too high? These are some of the questions which the accelerated wear tests were designed to answer.

The detailed conclusions which it has been possible to draw from the test are set forth below. Outstanding from these conclusions are two facts of major importance:

1. That rubber-tired traffic alone does not appreciably abrade the surface of a concrete pavement.
2. That there is no consistent relation between the results of the "tensile-strength-ratio" test for sand, the compression or transverse strength tests or the Talbot-Jones wear test of concrete, and the wear-resisting properties of concrete pavements.

Conclusions

Before attempting to draw general conclusions from these tests, it may be well to restate certain premises regarding the volume and character of traffic to which the test pavement has been subjected. These premises follow:

1. That on the average 18-foot concrete road, approximately 10 % of the total traffic moving in both directions passes over a band 6 in. in width at the point of maximum concentration. Therefore, the traffic passing over the test road should be multiplied by at least 10 to obtain the equivalent volume of traffic on an actual pavement.
2. That the comparative resistance of each test section to the

surface wear produced by the tire chains is an indication of the comparative resistance which would be offered by the concrete to wear or disintegration at the edges of exposed joints and cracks under service conditions.

3. That conditions which cause surface wear, such as steel tires, tire chains tracking through snow, etc., are present to such an extent as to make it necessary to give the question of wear consideration in the selection of concrete aggregates.

The authors believe that the data so far secured warrant the following conclusions.

1. That the rate of wear of stone concrete is, in general, not affected by the coarse aggregate, provided the coarse aggregate is equal or superior to the mortar matrix in resistance to wear.
2. That excessive wear will result from the use of very soft stone as coarse aggregate even though used in conjunction with a mortar of satisfactory quality. From the results of these comparative tests, it would appear that stone with a percentage of wear over 7 should not be used in concrete road construction.
3. That gravel concrete, in general, is at least as satisfactory from the standpoint of wear as stone concrete.
4. That gravels consisting essentially of siliceous materials are superior as regards both the amount and uniformity of wear to those containing a preponderance of calcareous fragments.
5. That gravels consisting of rounded particles are as satisfactory from the standpoint of wear as those consisting either wholly or in part of angular or crushed fragments.
6. That small amounts of shale occurring in the coarse aggregate will cause both excessive and uneven wear.
7. That the modified abrasion test for gravel in its present form is not an indication of the wear-resisting properties of coarse aggregates. It is suggested that if the severe impact action of the steel balls were decreased, much more indicative results would be secured.
8. That blast furnace slags should prove satisfactory for use in concrete pavements provided the proportion of light, porous slag is so controlled that the weight per cubic foot will be at least 70 pounds.
9. That the presence of large amounts of light, porous fragments in blast furnace slag will cause excessive wear.
10. That somewhat better results are secured by the use of the smaller sizes of slag.
11. That slag or stone screenings are, in general, unsatisfactory as substitutes for natural sand as fine aggregates in concrete road construction.
12. That the copper and lead smelter slags used in these tests would make satisfactory aggregates for concrete road construction from the standpoint of wear.
13. That coarse sands, other things being equal, show greater resistance to wear than fine sands.
14. That the so-called "tensile-strength-ratio" test is no indication of the wear-resisting properties of concrete made with these sands.
15. That the Talbot-Jones wear test is not, in general, an indication of the wear which takes place under traffic.
16. That neither the crushing nor the transverse strength of concrete is a measure of its wear-resisting properties.
17. That the addition of hydrated lime in the proportion used in these tests does not affect the wear-resisting properties of concrete.
18. That so far as resistance to wear alone is concerned, increasing the cement content beyond a cement-sand ratio of 1:2 does not materially affect the concrete. Leaner mixes on the other hand show marked increase in wear.
19. That unusual precautions should be taken in using mine chats or other similar harsh-working materials so as to increase workability to a maximum and thus make possible a smoother surface finish.
20. That, other things being equal, either an excessively dry or an excessively wet mix will show less resistance to wear than concrete of medium consistency.

White Filler for Road Joints

From an article by L. G. Carmick, Chemist, U. S. Bureau of Public Roads, in *Public Roads*, published by the Bureau.

Two years' trial of a light-colored material, developed by the Bureau of Public Roads, for use as a filler for joints and cracks in concrete roads, has demonstrated that the material has qualities which make it decidedly valuable for the purpose. Considering the lasting qualities of the material, it has also been demonstrated that it is certainly not much more costly than other fillers, and it is possible that it will be found to be no more expensive.

In the early part of 1922, the Bureau of Public Roads began a search for some material of about the same color as portland cement concrete that could be used for filling cracks and expansion joints in concrete roads. The bituminous materials which have always been used for this purpose are considered fairly satisfactory in most respects, but they unquestionably disfigure the road. A large number of different substances were experimented with and abandoned, which it is not worth while to mention here. However, after numerous failures a plastic material was found which seems to have most of the desired qualities.

CHARACTER OF THE MATERIAL

It is an intimate mixture of crude unvulcanized rubber with rosin in the proportion of one part of rubber to about ten of rosin, to which mixture is added a considerable quantity of a neutral white pigment, preferably barytes or titanox. Some difficulty was experienced at first in securing a homogeneous mixture of these materials, as rubber does not dissolve readily in melted rosin. But, eventually it was found that if the rubber were softened by allowing it to absorb about twice its weight of a light petroleum lubricating oil, and the mixture effected in a steam-jacketed iron vessel provided with revolving arms which exerted a mixing and kneading action, a smooth product could be obtained. This material differs in many respects from tar and asphalt. In color it is almost white, but it can be readily tinted to any desired shade. It is extremely sticky, especially when hot, and has a high degree of ductility. In these respects it resembles bituminous materials, but it is far less affected by temperature changes. It is more difficult to melt and even in the coldest winter weather met with in the vicinity of Washington it does not become brittle.

To use this material successfully these facts must be borne in mind. It may be melted in open kettles at the roadside, but the melting takes longer than with bitumens and care should be taken to prevent the material from catching fire and to avoid overheating. At a temperature of about 110° to 125° C. it is fluid enough to pour, and it does not become much more fluid even though the temperature be considerably raised, but the quality of the material is injuriously affected if heated much above this temperature. It was also found that it did not flow to the bottom of the cracks as readily as bituminous fillers, but this was overcome by the use of a hot iron implement with which it can be worked down into even very narrow cracks. The tool used at present somewhat resembles a laundry iron, but with a handle long enough to enable a man to use it without stooping uncomfortably. Two of these are necessary, one being heated while the other is in use. As soon as the material is poured into the crack it is gone over with the hot iron and in this way very good results are obtained.

BEHAVIOR AND COST OF FILLER

This crack filler has been used experimentally in several of the states and the reports have been generally favorable. It has also been used in the Columbia Pike, an experimental road constructed by the Bureau of Public Roads near Washington. Frequent inspections of the material as used in this road, and comparison with the several types of bituminous fillers also used provide the basis for the statements made in this article. On the Columbia Pike the cracks were filled with the new material in December, 1922. A recent inspection shows them to be in good condition still. The cracks are well filled and the material has shown no tendency to flow out or "bleed." Traffic has done it no harm. The cracks that were filled after the men had learned how to handle the material are particularly good. They are inconspicuous and, in some cases, almost invisible. Cracks that were filled at the same time with asphalt had to be filled again in September, 1923, and are now badly in need of further attention. The asphalt flows out causing an unsightly black streak in many cases several inches wide on each side of the crack.

This light-colored crack filler costs at present about 10 cents per pound which is, of course, much more than asphalt or tar, and furthermore it is not likely that its cost can be very greatly reduced. Also the labor cost of applying it is somewhat more than for asphalt and it was accepted as a fact in the beginning that it could not compete in price with bituminous fillers. Its use was felt justified, however, because in any case it would be a very small item in the cost of a first-class concrete highway, and the finer appearance of the road, due to the absence of black streaks was considered to be worth the additional cost.

However, in view of recent inspections it seems that its cost, taken over a period of years may not be so much greater than asphalt after all. For instance, cost data on the road mentioned show that filling cracks with asphalt cost $0.0075 per square yard of road for labor and material. The cost of the light-colored filler was about 1 cent per square yard for material and 1¼ cents for labor, the total being about three times as much as for asphalt. It is, therefore, apparent that if the light-colored material lasts three times as long as asphalt it will entail no greater expense. Experience so far seems to indicate that this will be the case.

Concrete Pipe Electrical Conduits

Article prepared by and published through courtesy of the Portland Cement Assn.

In most cities over 50,000 population, it has been found advisable to install transmission distribution systems for electric light and power in underground conduits. Such practice has been in vogue for a period of over 40 years, and although the initial cost of this type of construction is greater than for overhead construction, the final results prove it to be a measure of economy, because of the greatly reduced cost of maintenance of such a system. Overhead lines incur danger to life, they are unsightly, and subject to frequent interruptions of service during severe storms.

The principal kind of conduits or ducts used at present are the concrete or stone conduit, fibre pipe, and the multiple and single form of vitrified clay duct. All of these are installed in the same general manner.

Method of Installation

The single ducts are ordinarily installed in clusters of 4, 6, 9, or 12 lines, with joints staggered and duct lines separated by 1 in. of cement mortar and the group of ducts entirely surrounded by concrete with a minimum thickness of 3 in.

The concrete ducts or "stone conduits," as they are referred to commercially, are made in lengths of 3 ft., with an internal diameter of 3½ in., and a shell thickness of ⅝ in. Duct lines are usually laid at a sufficient depth to provide a cover of 2½ ft. over the top of the upper 3-in. layer of concrete.

An experienced workman with one helper can lay about 2000 duct feet in a prepared trench in an 8-hour day. After conduits are laid, the lines are rodded, and a steel mandrel, ¼ in. or ⅛ in. smaller in diameter than the inside diameter of the duct, is drawn through each line to insure that there are no obstructions and no offset joints which will prevent or even make more difficult the drawing of the cables through the duct lines.

Essential Qualities of Duct Material

A primary essential of any duct line is that it be designed and constructed in such a manner so as to offer the least possible frictional resistance to the passage of lead-covered cable. This requires an extremely smooth interior surface of the conduit, and no appreciable offsets at the joints, which would tend to shave off the lead covering as cable is pulled through.

Another essential characteristic that any conduit must have is that of effectively resisting the passage of electric arcs. Although the duct material cannot prevent a burnout in a cable, it should prevent the communication of this burnout to cables in adjoining lines, and after extended observation and experience, numerous electrical engineers believe that concrete meets this requirement better than any other duct material. It also successfully resists the action of heat caused by a cable short circuit.

Comparison of Various Materials

In this connection, the report of the Committee on Underground Construction of the National Electric Light Association in the 1911 proceedings contains the following statement:

> Conduit built with fiber or with concrete duct material and having tight joints resists the action of the heat of a cable short-circuit, either high tension or low tension, much better than conduits built of tile and with butted joints.

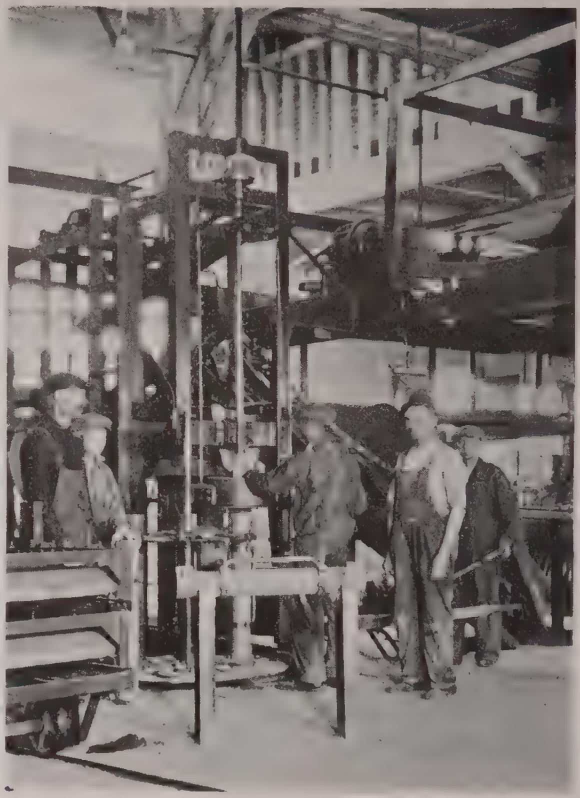


Fig. 1—Conduit Pipe Manufacture

As to the ability of concrete in comparison with other duct materials to resist passage of arcs, the same committee in the 1920 Proceedings of N. E. L. A. stated as follows:

> Concrete ducts being round, are laid with a minimum of one inch of concrete between adjacent ducts, with ⅝ in. duct walls. This gives over 2 in. of concrete between cables in adjacent ducts and *the committee has been unable to find any record of a burnout, of either high or low tension cable in concrete duct, communicating through the conduit to the cable in an adjacent duct.*
>
> Fibre ducts have inherently no great resistance to arcs, but their principal function is to serve as a mold for the concrete and the protection against troubles of this kind is afforded solely by the concrete between the ducts. (Minimum thickness of concrete between fibre ducts is ordinarily 1½ in.)
>
> Vitrified tile readily melts where exposed to arcs, and the trouble is particularly disastrous in the case of low tension cables which are not quickly disconnected in case of trouble. Numerous cases are on record where burnouts of low tension cables carried in vitrified tile conduits have melted the duct materials so that the molten tile and lead and copper have solidified into one solid mass and none of the cables in the conduit could be withdrawn. Such cases of trouble cause serious delays in the restoring of service, because they necessitate the digging up of the conduit, the removal of solidified tile, lead and copper, the removal of all the cable in the conduit, and the replacing of the damaged portion of the conduit, and later the replacing of all the cables.

In 1922, a questionnaire was sent out by the Underground Construction Committee of N. E. L. A. to a large number of electric light and power companies regarding the use of cement coverings for fireproofing cables in manholes. The use of such fireproofing materials was found from the replies to be the common practice of a great many concerns, and the number of cases where corrosion of lead under cement fire proofing has occurred is very small.

Its occurrence is, however, troublesome, as the exact cause of such corrosion cannot be exactly determined. It is apparent in some cases that the trouble is cathodic corrosion, due to the cable sheath being strongly negative to the adjacent electric rails during a portion of the day.

The following paragraphs relative to cathodic corrosion are quoted from the 1922 report of the abovementioned committee:

> If the cable sheaths are several volts negative to the surrounding rails or pipes during a portion of the time and at about the same potential as the rails during several hours, as, for example during the light load period in the early morning hours, then the cement will be decomposed by the action of the stray currents when the lead sheath is several volts negative and the alkaline products of this decomposition will attack the lead when the current ceases to flow. If the trouble is due to this cause, the difficulty can sometimes be removed by altering the conditions so that the cable sheaths will not be so strongly negative during the heavy load period on the adjacent electric railways.
>
> A number of companies have used a large amount of cement-lined iron pipe for conduits in the earlier days and more recently large quantities of concrete pipe have been used by some companies. The fact that these companies are not having trouble due to the lead sheath being in contact with the concrete, indicates that the trouble is not due primarily to the action of cement or concrete on lead, but that it is due to some local conditions such as cathodic corrosion above described.

Advantages of Using Concrete Conduit

Although the above advantages obtained by using concrete duct in preference to other materials are by far the most important, concrete has other inherent qualities which prove its superiority over other materials when used for this purpose.

As stated above, conduit lines are usually placed only 2½ ft. below the surface of the street, and are therefore subject to impact caused by passing vehicles. Electrical engineers state that concrete conduits withstand this impact far better than other materials.

At this depth (2 ft. 6 in.), conduits are also subject to action of frost, and it is a well-known fact that concrete conduits successfully resist such action at all times.

Concrete conduits are symmetrical throughout, straight and true from end to end, smooth and regular on the inside, free from blisters or other imperfections, and thus offer the least frictional resistance to the drawing of a cable through the bore.

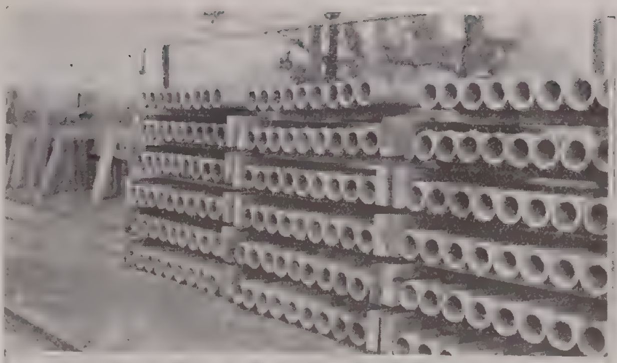
Little variation in the concentricity of inner and outer circumference is found in concrete conduits properly fabricated, and the ends are perpendicular to the barrel, which features facilitate the construction of even and smooth joints quickly and easily, such joints being essential to good conduit construction.

Although the first cost per duct foot of the various types of duct materials has been approximately the same for a number of years, experience has shown that the maintenance cost of a system using concrete is far less than that of the systems using other materials, the reason for this being that, as stated above, concrete conduit is less liable to damage from shock or vibration caused by passing vehicles, more resistant to frost action, and not appreciably affected by cable burnouts.

Extensive Use of Concrete Conduit

In many cities throughout the country, concrete conduits have been used by electric light and power companies for a number of years, and the advantages gained by using it are brought out by the fact that the number of duct feet installed each year is rapidly increasing.

Probably the best illustration of this fact is afforded by citing as an example the Commonwealth Edison Co. of Chicago, which now prefers concrete conduits to the exclusion of all other types, and maintains (under a subsidiary company) its own plant for the manufacture of this material. This plant, on the Chicago river at Addison St., is equipped with four McCracken machines for making "stone" conduit pipe, together with the necessary facilities for handling materials and handling and curing the finished product. A separate room is used for making curves and other special fittings, which are molded by hand. The concrete used is of the so-called semi-dry consistency mixed, 1 part of portland cement to 3 parts of No. 2 torpedo sand or limestone screenings. The conduits are cured for a period of not less than 8 weeks after removal from the molds, being kept wet by sprinkling the first six weeks, and then allowed to dry in the air for 2 weeks before being used.



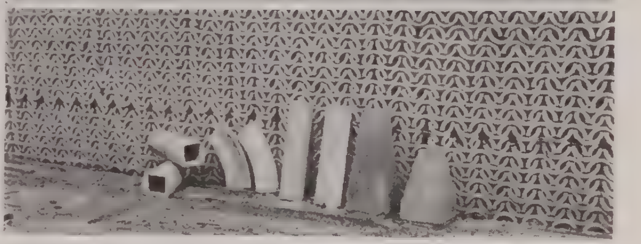


Fig. 2—Conduit Lengths Are Stored on Racks for 24 Hours; Then Semi-Circular Pallets or Half Molds Are Removed and Pipe Are Stood on End in Yard

Fig. 3—Plant and Storage Yard "Stone Conduit"—Made of Concrete

Fig. 4—Half Sections of Conduit for Repair Work; Half Bends, 12 in. and 18 in. Bells Used at Manholes and Substations

Although the capacity of this plant is about 3000 duct ft. per day, or about 900,000 ft. per year, it was unable to supply the demand in 1923, and the company was compelled to resort to the use of fibre duct. To overcome this situation, a contract has recently been awarded to others for the manufacture of 3,000,000 ft., and a plant for this purpose is now being erected in Chicago.

The Commonwealth Edison Co. engineers estimated that they have used over 18,000,000 ft. of stone conduit during the past 30 years, and estimate their present requirements at approximately 2,000,000 duct fr. per year.

Following are specifications for stone concrete conduits of the American Railway Engineering Association:

Note—Since these specifications were prepared the Commonwealth Edison Co. has discarded its old machines used in the fabrication of the conduit and installed four modern machines of the packer head type. Conduits are 3 ft. long and 3½ in. internal diameter.

1. *Material*

Stone conduit shall be made of limestone screenings or sand which will pass through a screen of ⅛ in. mesh and approved make of portland cement in the proportion of 4¾ to 1 properly moistened with water and shall be formed by tamping in cylindrical molds.

2. *Dimensions*

Conduit shall be made in lengths of 5 feet with ⅝ in. walls and 3½ to 4½ in. round bore.

3. *Workmanship*

(a) Conduit shall be symmetrical throughout, straight, true, smooth, free from cracks, air holes, uneven surfaces or other imperfections which will injuriously affect it. The ends shall be perpendicular to the bore.

(b) Conduit shall be cured for not less than 8 weeks after removal from the mould. For the first 6 weeks it shall be kept wet by sprinkling and then allowed to dry in the air for at least 2 weeks.

4. *Joints.*

(a) Conduit when thoroughly cured shall be turned, for a distance of ¾ of an inch on each end, sufficient to secure an exact diameter concentric with the bore, but which shall not reduce the thickness of the wall given in Section 2 by more than 1/16 of an inch.

(b) With each conduit there shall be supplied a suitable metal sleeve which will fit tightly over the ends of adajcent conduits to hold them in place and to secure perfect alignment.

5. *Short Lengths.*

Pieces of conduit less than the standard 5 ft. length will be accepted, not to exceed 10% of the total ordered, provided the ends are cut square, dressed and turned for metal sleeves, but no conduit will be accepted less than 2½ ft. long.

6. *Inspection.*

(a) The Railroad may inspect the conduit at any time during the process of manufacture and shall be furnished free of cost the necessary tools and appliances for making such tests as are necessary to determine if the requirements of these specifications have been met.

(b) Conduit offered for inspection shall be factory run from which no conduit of a superior quality has been removed.

(c) The railroad shall be given advance notice of completion of conduit to permit it to arrange for inspection.

7. *Tests.*

(a) Conduits shall permit the passage from end to end of a mandrel 3 ft. long and ⅛ in. less than the nominal diameter of the bore.

(b) Samples of 5 ft. lengths of conduit shall be selected at random and after immersion for 24 hours in water shall show an increase in weight of not more than 9/10 of 1%.

(c) The presence of cracks shall be determined by sounding each piece with a steel hammer or its approved equivalent. Pieces which fail to give a clear metallic ring shall be considered defective.

(d) Conduit which fails to meet all of the requirements of these specifications shall be rejected.

8. *Installation.*

(a) Conduit line shall be encased in concrete 4 in. thick on top, 3 in. on the sides and a minimum thickness of 4 in. for the full width of the trench, except where ledge rock is encountered; in which case the concrete foundation may be omitted and the bottom of the trench leveled with cement mortar. Conduits shall be laid with a minimum separation of 1 in. both horizontally and vertically and the joints shall be staggered so that the joints of adjacent sections will be separated by at least 3 in.

(b) In ending conduits only full lengths shall be used in the lower tier at the entrance to splicing chambers. Short lengths where necessary shall be inserted further out in the section.

(c) Where work is suspended leaving incompleted sections the open ends of the conduits shall be plugged with tapered wood or other approved plug conforming accurately to the shape of the bore and so formed that it cannot be forced entirely within the opening

(d) During construction work a mandrel 3 ft. long and ⅛ in. less than the nominal bore shall be drawn through the conduits as they are laid.

(e) In other respects the methods of laying stone conduits shall correspond to the American Railway Engineering Association Specifications for Fiber Conduits.

For the convenience of the traveling public, the New Jersey Highway Commission has issued a new road map of the state. The paper is of a quality to withstand frequent handling and the entire work has been carefully planned. Accurate information is presented on the mileage of the different routes and the latest reports are carried about the roads under construction. The system of marking poles along state highway routes to designate the direction, as North-South or East-West, followed by the roads, is explained and attractive views are shown of completed thoroughfares.

American Society for Testing Materials

A number of interesting subjects to users of cement and concrete were brought up at the twenty-seventh annual meeting of the American Society for Testing Materials held at Atlantic City, June 24 to 27. A wide range of subjects was touched upon, including concrete brick, concrete sewer pipe, cement and concrete. F. M. Farmer, chief engineer of the Electrical Testing Laboratories, New York, was elected president and J. H. Gibboney, vice president of the society.

The report of committee C-3 on brick, which includes a specification for concrete building brick was presented at the meeting and accepted. Specifications for both concrete and clay sewer pipe were adopted as standard and a proposed lighter weight pipe taken under consideration as an alternative to the provisions of the present standards. A tentative change in the specifications for concrete sewer pipe was added against the use of concrete sewer pipe where the sewage shows an acid reaction.

The report of the committee on cement brought out the facts that several suggestions submitted have been studied by the committee and a laboratory manual for the testing of cement is in preparation to be ready next year. A sub-committee has been formed to consider all other types of cement than portland. Suggestions which have been submitted as to revisions of the current standard specifications for cement include the dropping of the specific gravity provision, a shorter period for strength test than the seven-day mortar test, compression test for mortar, a change in the sulfur and magnesia content qualities and the restoration of the 100-mesh fineness test.

Several papers were presented dealing with concrete in service and "Accelerated Wear Tests of Concrete" in particular, by F. H. Jackson was followed by a discussion by highway engineers and by Duff A. Abrams of the Structural Materials Research Laboratory. The idea was emphasized that the tests must be interpreted by men familiar with service conditions. Iowa gravels which seemed to show up poorly in the tests, although they are the only gravels available in the state, are considered by the Iowa State Highway Department as less desirable for use in road work, in the light of the test results reported.

The specifications prepared by the Joint Committee on Concrete and Reinforced Concrete were not available and it was stated by Richard L. Humphrey, chairman of the committee that they would be printed in the August *Proceedings* of the American Society of Civil Engineers. What the committee considers the most important points covered in the standard specifications and their variations from the preliminary standards submitted three years ago, were described in the committee report. The specifications were submitted by the committee as a compromise agreement and although not every member agreed to all the report, they all agreed in the publication as the best compromise that could be reached. It was pointed out by the chairman that the two main points on which the standard specifications and the tentative specifications differ are that the clause in paragraph 28, referred to as the strength design clause, has been omitted and that the provision that the use of integral waterproofing be prohibited has been changed to permit the use of integral waterproofing compounds only when the engineer specifically orders them.

Two methods of getting the desired strength in proportioning and mixing are defined. The proportions, including the water, as well as the consistency, are set by the engineer, according to his own analysis of the aggregate, or a secondary method to be used when there is not sufficient time for the first method or when the aggregate is not known, the proportions being arbitrarily fixed by the engineer, who is to be guided by the table of proportions in the earlier report of the committee. The time of mixing, under the new specification, is changed from 1½ min. as of the earlier report, to 1 min.

Details which are enlarged upon in the committee's latest report and included under design refer to splicing of reinforcement, protection of reinforcement against entrance of moisture, expansion and contraction, fire protection and the relation of different grades of aggregate rated according to their fire resistance and the basing of the spirals in column design on the amount of vertical reinforcement. Flat slab design methods specified follow the Westergaard and Slater analysis and are somewhat similar to the present Chicago rule, and in some cases unit stresses are revised upward on the basis of the additional care specified in the work.

Cinder Block Efficiency in Pier Tests

Tests of Straub cinder concrete block at Columbia University Testing Laboratories show ratios of .758, .700 and .547 between compressive strengths of individual units and of piers built of similar units.

Tests were made for three licensed manufacturers of Straub block—Bergen Building Block Co., Ridgefield Park, N. J., Hudson Fireproof Block Co., Homestead, N. J., and Brooklyn Crozite Brick Corp., Brooklyn, N. Y.

The following is from the Columbia University report:

The tests consisted of compression tests on Straub Cinder Concrete Block, and upon piers built with these block. The cinder concrete block and materials entering into the construction of the piers were furnished by the above manufacturers.

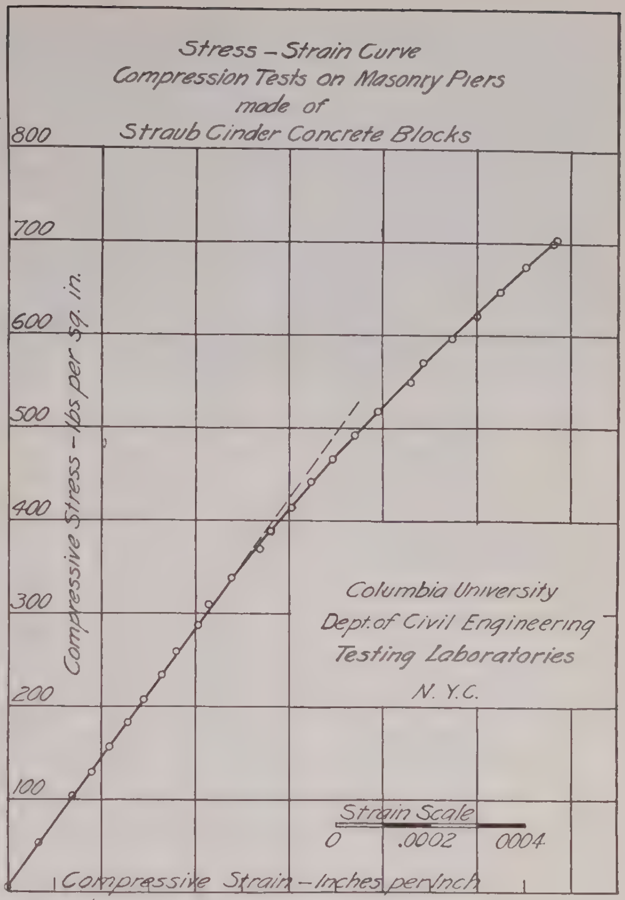


Fig. 1

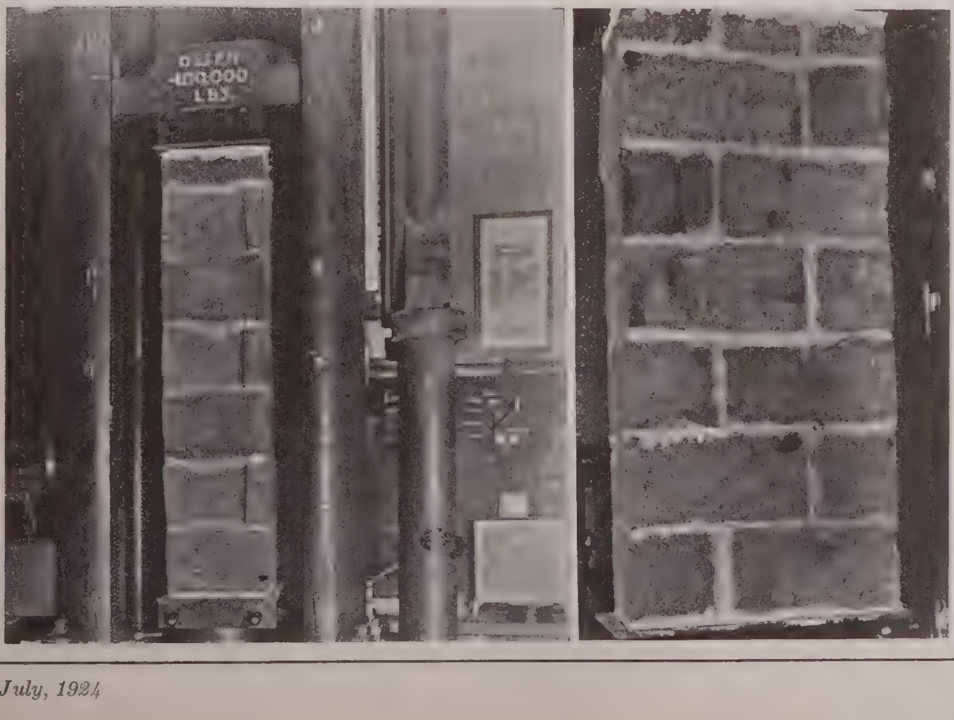
Construction of Masonry Piers

The masonry piers tested were constructed of Straub block by a mason furnished by the manufacturers. Three piers of the following dimensions were constructed:

Pier No. 1—Composed of 8x8x16-in. two-cell block. Pier, 8.05x23.92x54.10 in. high. Pier consisted of six courses of 8x8x16-in. and 8x8x8-in. block with joints broken and one top course composed of a 4x8x16 in. and 4x8x8 in. solid cinder block.

Pier No. 2—Composed of 8x8x16-in. two-cell block. Pier, 8.15x23.90x53.8 in. high. Constructed same as Pier No. 1.

Pier No. 3—Composed of 8x12x16-in. three-cell block. Pier,



Figs. 2 and 3

12.40x24.0x54 in. high. Pier consisted of six courses of 8x12x16-in. and 8x12x8-in. block, with joints broken and one top course composed of three 8x12x8-in. solid cinder concrete block.

The block were laid up in a portland cement mortar, mixed in the proportions of one part cement and three parts sand, and stored indoors for a period of twenty days.

All of the above piers were provided, both at top and bottom, with ½-in. steel bearing plates, set in a mortar bed, so as to insure a uniform bearing on each end of the pier.

Method of Test

The masonry piers were placed in a 400,000-lb. Olsen testing machine provided with a spherical bearing plate and tested to failure in compression. Pier No. 1 was subjected to the compressive loads in increments of 5000 lbs. and the corresponding compressive strains measured. Piers No. 2 and No. 3 were loaded to failure without measurement of the compressive strains.

Three 8x8x16-in. block and three 8x12x16-in. block, similar to those used in the construction of the piers were tested individually in the same testing machine to determine their ultimate compressive strength. These specimens were provided with plaster of paris bearing surfaces before test.

Results of Tests

The following table gives the results of compression tests made upon the three masonry piers:

Test No.	23748	23749	23750
Specimen	No. 1	No. 2	No. 3
Height, ins.	54.10	53.8	54.0
Width, ins.	23.92	23.90	24.0
Thickness, ins.	8.05	8.15	12.40
Gross area, ins.	192.6	194.8	297.6
Maximum load, lbs.	135,600	126,500	214,000
Ultimate strength, lbs. per sq. in.	704	649	719
Weight, lbs.-oz.	469-4	469-0	703-4

The following table gives the results of compression tests on individual block, similar to those used in the construction of the piers:

Test No.	23751	23752	23753	23754	23755	23756
Specimen	8x12x16-in. Block			8x8x16-in. Block		
Mark	1	2	3	4	5	6
Length, in.	16.02	15.90	15.90	15.95	15.80	15.94
Width, in.	12.40	12.40	12.25	7.98	8.02	8.02
Height, in.	8.04	8.12	8.00	7.80	7.82	8.00
Gross Area, sq. in.	198.6	197.2	194.8	127.3	126.7	127.8
Net Area, sq. in.	135.1	133.7	131.3	86.7	86.1	87.2
Max. Load, lbs.	240,620	262,770	272,900	113,250	113,430	126,680
Ultimate Strength, lbs. per sq. in., Gross	1,210	1,330	1,405	890	895	992
Net	1,780	1,965	2,080	1,305	1,315	1,455
Weight, lbs.-oz.	59-0	59-12	61-8	38-0	38-10	39-8
Average Strength, based on gross area, lbs. per sq. in.		1,315			927	

The loads and corresponding compressive strains determined from test upon Pier No. 1 are as follows:

Stress Strain Data

Pier No. 1. Dimensions—8.05x23.92x54.10 in.
Gage length, 34.85 in.
Area, 192.6 sq. in.

Applied Load lbs. per sq. in.	Strain, Inches per Inch	Applied Load lbs. per sq. in.	Strain, Inches per Inch
5	0	5	.0000402
52	.0000622	389	.000560
104	.000136	415	.000605
130	.000179	442	.000647
156	.000216	467	.000691
5	.0000060	493	.000742
184	.000255	519	.000788
208	.000290	550	.000860
234	.000325	571	.000886
260	.000359	597	.000950
5	.0000175	622	.001002
288	.000403	649	.001053
312	.000426	675	.001104
338	.000477	700	.001163
370	.000537	704 Maximum	

Modulus of elasticity as determined from the above data is 698,000 lbs. per sq. in., based on the intensity of stress on the gross cross section. Based on a net section of 130 sq. in., the modulus of elasticity would be 1,035,000 lbs. per sq. in., approximately.

From the above tests, the ratio of the compressive strength of the masonry pier to that of the individual block based on gross cross sectional area is as follows:

Pier No.	Compressive Strength of Pier	Compressive Strength of Block	Ratio
1	704	927	.758
2	649	927	.700
3	719	1315	.547

Note—Piers 1 and 2, composed of 8x8x16-in. block.
Pier 3 composed of 8x12x16-in. block.

The curve, Fig. 1, shows the stress-strain relation for Pier No. 1 graphically.

The illustrations from photographs, Figs. 2 and 3, show Pier No. 3 in the testing machine before test.

Certificates of Quality

"Instead of calling upon the National Association for Certificates of Quality this year, your Executive Committee has decided it best if we issue our own Certificates," says a bulletin of the Wisconsin Concrete Products Association, to members. Attached to the bulletin was a replica of Certificate Number 4, issued to the Badger Concrete Co., Oshkosh, Wisc. If you are entitled to a Certificate and have not already received it, do not think you have been forgotten. It takes no small amount of time to make out the Certificate and have the proper signatures appended. You will notice that *each Certificate bears the name of W. C. Muehlstein, Building Engineer of the Wisconsin Industrial Commission.* The Certificate will come to you framed, ready to hang upon the wall of your office where all may see that your products comply with the requirements of the Wisconsin Building Code as attested by Mr. Muehlstein."

Regulations governing issuance of Certificates are as follows:

Regulations Governing Issuance of Certificates of Quality
Wisconsin Concrete Products Association

1. Certificates will be based on tests of standard product selected by the secretary of the Wisconsin Concrete Products Association, his duly authorized representative or a representative of the Wisconsin Industrial Commission or local Building Department.
2. Specimens must be tested at an accredited testing laboratory at an age of 28 days, and pass the requirements of the Wisconsin Building Code.
3. Certificate of Test bearing the signature of the head of laboratory in question must be furnished the Wisconsin Concrete Products Association before Certificate of Quality is issued.
4. Continuance of the quality shown by above tests must be maintained by the products manufacturer. Failure to maintain this quality means a revocation of Certificate.
5. All Certificates issued will expire at the end of membership year.
6. Certificates of Quality are issued only to members in good standing of the Wisconsin Concrete Products Association.
7. In cases of concrete products other than concrete building units, issuance of Certificate of Quality is based on Standards of American Concrete Institute, or of the American Society for Testing Materials, and will be issued accordingly.

New Books

The Engineering Index for 1923, compiled and published by the American Society of Mechanical Engineers, New York City. Size, 6½ in. x 9½ in.; 700 pages; cloth binding. Price, $7.00.

The 1923 Engineering Index is the fifth to be issued since the American Society of Mechanical Engineers acquired the index from the Engineering Magazine Co. and assumed the continuation of the service first started 40 years ago by the Association of Engineering Societies of reviewing periodicals, reports, and other publications received through the Engineering Societies Library in New York. Approximately 650 periodicals and reports have been indexed with cross references, and many 1922 publications received too late for the last volume, have been indexed in the present book.

As both foreign and domestic publications are indexed, the book is of considerable value to anyone interested in learning what information has been published on an engineering subject either at home or abroad.

Surveying and Boundaries, by Frank Emerson Clark. Bobbs-Merrill Co., publishers, Indianapolis, Ind. Size, 5½ in. x 9 in.; 630 pages; illustrated; cloth binding. Price, $5.00.

As a treatise on the law of surveying and boundaries, containing particular reference to disputed boundary lines and riparian rights, this book will be of considerable value to all surveyors, as it contains much information not found in concise form in other books.

The author of the book is a lawyer and a surveyor of extended experience, and treatise supplies the necessary knowledge required in dealing with difficult situations arising in connection with boundary surveys. The book will be found of particular use to highway engineers and to lawyers and surveyors in general. Numerous diagrams and illustrations are included in connection with the numerous cases at law cited in the book. The historical outline of the original methods employed in surveying public lands is of particular interest, and the descriptions of how present surveys are made are of value.

THE PRINCIPLES OF IRRIGATION ENGINEERING, by F. E. Kanthack. Longmans, Green & Co., New York City. Size, 5½ in. x 8 in.; 300 pages; illustrated; cloth binding. Price, $9.00.

In this book, which deals briefly with concrete construction work as applied to irrigation structures, the author deals more fully with the proper methods of analysis and the use of various data on which irrigation and more especially storage projects are based. The book is prepared with special reference to South Africa, and is based on a course of lectures delivered at the University of Cape Town.

In presenting the lectures in book form, it is the author's expressed hope to be of assistance to students and engineers, not only in South Africa but in other countries, and to call attention to the great limitation of knowledge on many matters on which irrigation science and engineering is based, and to thus stimulate research.

The layout of land to be irrigated, distribution of water, and prevention of deterioriation of the land by brak or alkali salts, so as to maintain the agricultural efficiency of this land, are dealt with. Other subjects treated include: rainfall, run-off, high floods, reservoir and canal losses, conservation of water, silt, duty of water and canal capacities, distribution and irrigation law.

New English Mixer for Impervious Concrete

Patents have been recently taken out, in England, for both the general principles of a new machine, as well as the machine itself, for a concrete and mortar mixer which is designed to effect a perfect blend. The principle applied is entirely new.

Into a projecting end of a rotating drum, roughly mixed aggregate is charged, at a rate which is automatically adjusted to the capacity of the machine. Water is added, under perfect regulation. As the thoroughly moistened aggregate reaches the drum, it is exposed to the cement, which is introduced at the opposite or discharging end of the drum. This introduction is effected by a fan, which produces a cloud of cement within the drum. The quantity of cement added is adjusted and automatically maintained so long as cement is kept supplied to the cement hopper.

Within the drum the moistened aggregate acquires a complete film of cement, and the temporary separation of the larger and smaller aggregate allows each particle to receive its portion of cement. The coarser and finer aggregates are perfectly mixed in the rotating drum before reaching the point of discharge. A homogeneous product results, the feature of which is the unbroken coating of cement on each grain of aggregate. The resulting concrete is characterized by its strength.

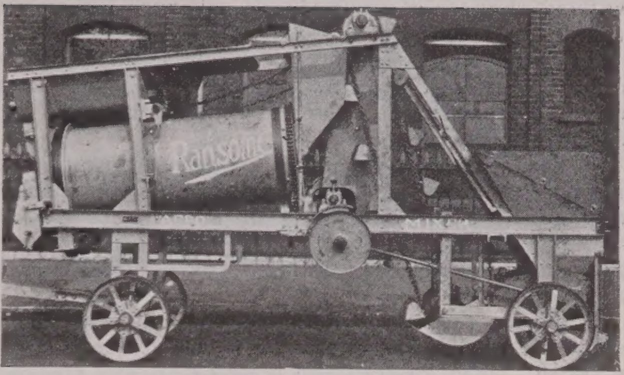


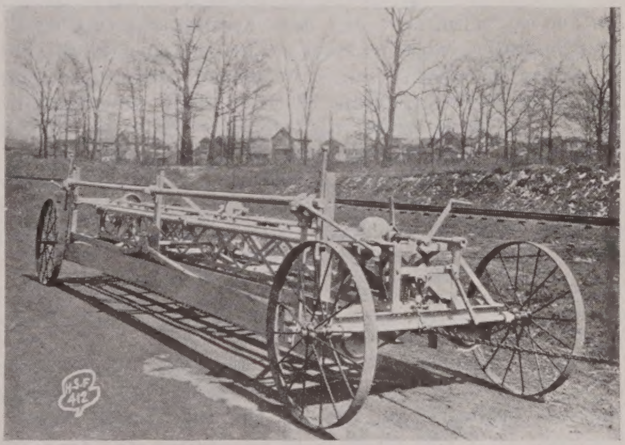
FIG. 1—NEW RANSOME AERO MIXER, TYPE A, FOR BUILDING CONSTRUCTION. CAPACITY 12 TO 16 CU. YDS. PER HOUR

Undoubtedly the secret of impervious concrete lies in the thorough incorporation of the constituents, and each particle of the aggregate requires to be completely covered with cement in order to eliminate even the most minute voids.

Hand-mixing, which certainly left much to be desired, duly gave place to mechanical types of mixers, which, however, failed to bring about perfect cementing of the whole of the aggregate, according to the makers of the new mixer. Careful study has led to the production of the above described patented machine, known as the Aero. The machine is made in three types, one of which—the A type— has a capacity of 16 cu. yds. of finished concrete per hr. It is made by the Ransome Machinery Co., 16 Grosvenor Gardens, London, England.

Hand Road Finishing Machine

The picture shows the new Heltzel hand operated finishing machine of the Heltzel Steel Form & Iron Co., Warren, Ohio. It is in some respects similar to the Heltzel power finishers placed on the market early this year, having many of the same parts; however, the engine, transmission and other parts being unnecessary, the new machine costs a good deal less.



Some years ago the Heltzel company made a number of hand operated finishers, some being still in use in various parts of the country. They had a drawback in the fact that they were not adapted to all classes of work, and for this reason were withdrawn from the market. J. W. Heltzel redesigned them and added improvements. The new model is heavier and pushes a greater body of concrete forward in striking off, without slippage of track wheels and with less power than the older models.

In front is the strike-off which spreads and strikes off the concrete to the proper crown. While striking off, it compresses the concrete firmly each time the strike off reaches the center of travel.

Following the strike off is the tamp, which can be regulated to strike at both ends at once or by a slight adjustment tamp alternately at either side. When working alternately only one half the power is required in operating the tamp, and this was one of the pleasing features of the old type.

Following the tamp, the finisher is equipped with a rubberized belt of generous width, which works automatically when lowered and is automatically stopped when in raised position.

Two men are required to operate the hand model, but if conditions are right and the mix is not too dry nor too wet, the machine will give a perfect finish the first time over and the operators can spend most of their time in doing other work. Where the mix is very dry the machine should be run over the work twice. To get best results, the manufacturers say, with a hand operated finisher, the slump of concrete should not be less than one inch, nor greater than two or three inches.

These hand finishers will work back of any of the largest mixers and will handle all the concrete that is possible to mix. Most of the older models worked back of 21-E's.

The New Anchor Stripper

New Anchor stripper outfits are announced by the Anchor Concrete Machinery Co., Columbus, Ohio, with many improvements and advantages over the old Anchor stripper block machine. Three styles give a wide range of production possibilities. The Anchor power stripper while not a recent development is one of the units included in the Anchor line. This machine feeds, finishes and strips all by power. The two types of Anchor hand strippers have been developed recently to replace the old type stripper. The new features of these machines are bound to commend interest from men who are interested in improved production methods. They are built to withstand hard usage; built low to eliminate any floor adjustment to provide a satisfactory working level. The design is such that it requires no foot pedal. The manufacturers say that one of the most important features of the new machine is the ease with which the block is stripped; with a lever range far less than any stripper on the market. The new Junior stripper is furnished with either floor tamper, power feeder and elevator or with suspended tamper. The former style gives increased production and is adaptable for any sized plant.

Wet Mix Building Tile

A new unit mold to employ a stiff wet mud mixture rather than a dry tamp in making concrete building tile has been put on the market by Merrill Moore, Creston, Ia. The mold is in one piece, self racking, self locking, and is intended for the production of units in three sizes, 5 x 8 x 12 in., 8 x 8 x 16 in.; and 4 x 5 x 12 in. The block are molded by using a vibrator, either hand or power equipment. A combination hopper and core is removed immediately the concrete is compacted by vibrating. Thus for many molds only one hopper and core is required. Green block are racked in the molds in a small room where heat may be used for hastening hardening. In this way the manufacturer says the molds can be used every day, even in cold weather.

Improved Steel Road Form

An *Improved Armor Plate Steel Road Form* is announced by the Heltzel Steel Form & Iron Co., Warren, Ohio. It is made with unusually rugged construction, providing such substantial reinforcement at the rail joints that a two-ton moving load was supported without any deflection at the rail joint, with subgrade excavated 3 feet on each side of the joint.

The reinforcing joint is made 15 in. in length, with two heavy steel swivel stake pockets approximately one foot apart and acting as expanding members, which force the head of the rail joint up under the tread of the $\frac{3}{16}$-in. thick steel rail.

Steel stakes are provided, made of 1½ in. x ¼ in. steel plate, sharpened at the ends. These stakes are made of special rolled high carbon steel and can be driven through ¼-in. boiler plate.

The steel stakes are locked to a stake pocket by anchor locking lugs.

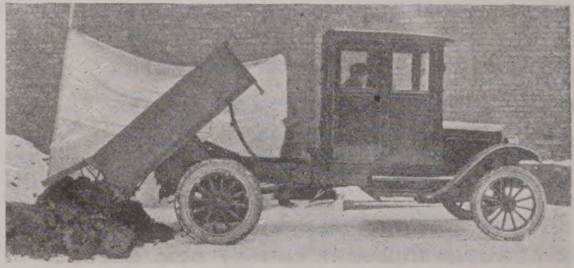
In setting the Heltzel Improved Form, the line is run to grade, the stake pocket thrown into a perpendicular position by an expanding bar provided with the form, and then the stakes are driven and the anchor locking lugs put into place by heavy blow with a sledge.

Nothing is bolted or riveted to the road rail, hence single or double stake pocket reinforcements can be placed anywhere along the rail that additional support is desirable.

The Heltzel Reinforcing Joint is so substantially built that no deflection is possible under the weight of heavy finishing machines or due to the rack and thrust of subgraders.

Inasmuch as the stake pocket swivels, the stakes can be driven at any angle when stony ground is encountered.

In case it is desired to remove any section of rail to permit a truck to drive through, the stakes can be easily pulled, separating this section of rail, and the rail lifted out and later replaced without disturbing adjoining sections of rail.



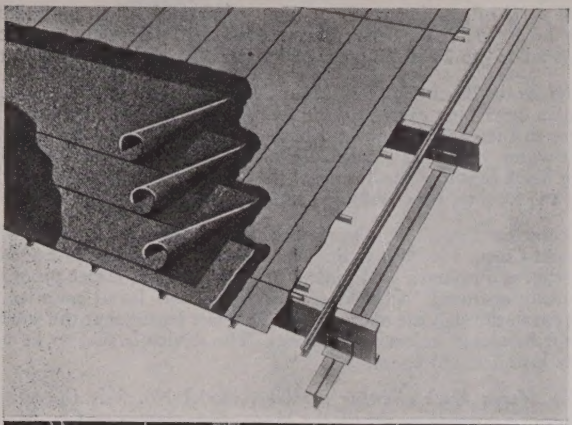
JIFFY DUMP BODY FOR CHEVROLET TRUCK

Jiffy Dump Body

The accompanying illustration shows the Jiffy triple duty body for the Chevrolet truck. It combines self-operating gravity dump, express body, and with simple extra attachment, a hoist type dump. The Jiffy dump body, according to the manufacturers, can be dumped in a jiffy by gravity and returned in a jiffy by hand from the driver's seat.

This equipment is now being built for the Chevrolet truck, as well as for the Ford. The Jiffy Chevrolet body weighs only 890 lb., and has a capacity of 1¼ cu. yds. when loaded to water level. It is made of No. 10 gauge steel, bottom and sides in one piece with no seam, electric welded construction throughout.

The Jiffy body is manufactured by the Griscom-Russell Co., 90 West St., New York City. This company has been engaged in the manufacture of high-grade engineering products for more than half a century.



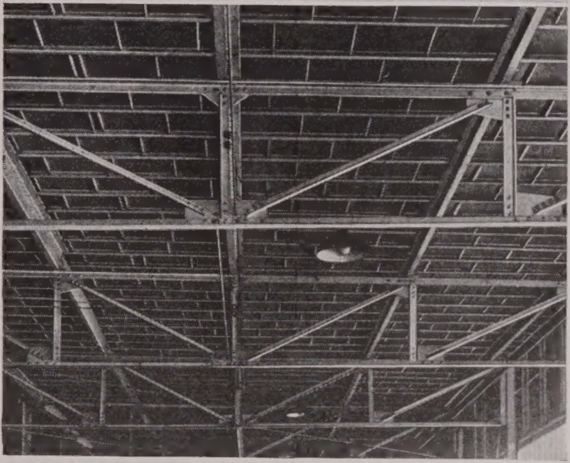


FIG. 1—TOP VIEW OF THE TRUSCON STEELDECK ROOF, SHOWING HOW THE POSITIVE BOND BETWEEN THE STEEL DECK AND BUILT-UP ROOFING IS SECURED

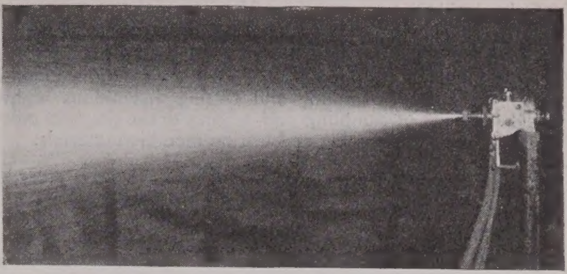
FIG. 2—UNDERSIDE VIEW OF ROOF, SHOWING SMOOTH SURFACE, EASILY PAINTED

New Lightweight, Fireproof Roof

A new improved roof construction which makes possible flat roofs with slopes of ½ in. in 12 in. and which are weathertight, durable, and economical, has been announced by the Truscon Steel Co., Youngstown, Ohio. The new roof type is the result of tests and experiments with varied types and principles of construction employing many combinations of roofing materials.

The deck is of copper steel, with stiffening angles welded to the plates to add strength and rigidity. Eaves, gables, ridges, and gutters are reinforced. The flat, true surface, it is claimed, is ideal for the application of the built-up roofing materials which are cemented to the steel with roofing pitch. The resulting roof is non-combustible, designed for a 40-lb. live load, and weighing but 4½ lb. per sq. ft. It has been tested to 160 lb. per sq. ft. without failure, and it makes possible a saving in the cost of purlins, trusses, columns, and foundations. It is claimed by the manufacturers that the roof will last indefinitely.

Owing to simplicity of construction, the underside of this steel deck roof shows a clean, smooth surface, and is easily painted to form an ideal reflector of light. It is standardized and factory built in units, which saves in the cost of production, the large units allowing speedy erection and saving in labor. Expansion and contraction are automatically taken care of at the joints, preventing cracking, sagging, twisting, or warping. The roofing is built up on the job following the placing of the steel deck, and is cemented with no open lap or joint.



THE METALAYER IN ACTION

New Metal Coating Gun

The accompanying illustration shows the Metalayer, manufactured by the Metals Coating Co., of America, Philadelphia, Pa., as it appears in action in the Schoop process of metal spraying. It is stated by the manufacturers that coatings of any of the commercial metals are simultaneously melted, atomized and impacted on any surface, either in adherent or separate form. The equipment is recommended as adapted for use either in the shop or in the field, on any material regardless of its size, character, shape, or position.

The Metalayer weighs only 3½ lb., and in use is connected to standard acetylene and oxygen cylinders and to a supply of compressed air. Metal, in the form of standard gauge wire, is automatically pulled from a reel into the rear of the gear case and fed uniformly and continuously at a rate of from 12 to 24 ft. per minute to the nozzle of the short barrel, where it enters into a continuous reducing flame zone developed from the gases and air, and is there melted and blown at a velocity of about 3000 ft. per second. in a very fine spray onto the surface being coated.

Trade Publications

Locomotive Crane Book No. 670—Covering both Link-Belt crawler and Locomotive cranes, this book is as interesting a work as any we have recently seen. It has been built along the idea that a picture will tell as much as two paragraphs. Hence it is profusely illustrated with excellent operation views.

Why Summer Concreting Needs Cal is the title of a 4-page folder 8½ in. x 11 in. reprinted by the Security Cement and Lime Co., from its Architects Loose Leaf Catalog. The compressive strength of mortar, at various ages, treated with Cal is discussed with directions for waterproofing and curing with Cal. The folder is issued by the Security Cement and Lime Co., Hagerstown, Md., manufacturers of Cal.

Building Code Requirements for Lime has just been issued by the National Lime Association, 918 G. St., N. W., Washington, D. C., being the tentative standards adopted by the Building Officials' Conference April 9, 1924. This is the Lime Association's bulletin No. 309 and offers sections suitable for direct incorporation in new or revised codes. The clauses and sections contained in the bulletin are given as the result of years of experience and bear the stamp of approval of the Building Officials' Conference which adopted them as tentative standards at the 1924 convention at Louisville, Ky.

The bulletin not only contains building code requirements for the materials and mortar, but also gives maximum allowable working stresses for various kinds of masonry. Directions are also given for laying masonry in freezing weather and for the use of hydrated lime in concrete.

The United States Department of Agriculture has issued department bulletin No. 1216 under the heading *Tentative Standard Methods of Sampling and Testing Highway Materials* dated May 1924. The Bulletin is 6 in. x 9 in., contains 96 pages, with paper covers and is illustrated.

The tentative standard methods of sampling and testing highway materials set forth in the bulletin are those recommended by the committee on tests and investigations of the American Association of Highway officials. They were adopted by the association at its annual meeting at Kansas City, Mo., December 1922, and have since been approved by the Secretary of Agriculture for use in connection with the administration of Federal Appropriations for Construction of the Federal Aid Highway System, superseding for this purpose, the methods described in department bulletin 149, standard and tentative methods for sampling and testing highway material. The contents include: Methods of sampling and testing non-bituminous highway materials; methods of sampling and testing bituminous highway materials; methods of sampling and testing drain tile and culvert pipe; and methods of sampling and testing metallic materials.

Austin Portable Belt Conveyors is the title of a 4-page folder, 8½ in. x 11 in. issued by the Austin-Western Road Machinery Co., Chicago, Ill. The folder describes portable belt conveyors which are coming into general use around industrial plants, crushing and screening plants, in yards of coal and building supply dealers and around road building jobs and which have proved to be labor, time and money savers. The more important features of the Austin conveyors are described and illustrations show the conveyors with both gas engine and electric motor drives.

Leach Oshkosh 7-S mixers are described in a folder issued by the Leach Co., Oshkosh, Wis., formerly the Oshkosh Mfg. Co. The folder is 8½ x 11 in.; four pages and contains illustrations of the 7-S mixer equipped with two-cylinder LeRoi engine, power side loader, water tank and rubber-tired disc wheels, and also with wheelbarrow charging hopper, steel wheels and arranged to operate discharge chute from charging side. Special features of the Leach-Oshkosh 7-S mixer are pointed out.

Portable Loader Book No. 650—This forty page book, issued by the Link-Belt Co., Chicago, Ill., covers the complete line of Link-Belt industrial loaders, which includes the Cub portable belt conveyor, the Grizzly power-swiveling loaders which run on either crawler treads or traction wheels, and their standard types of bucket loaders for handling coals, sand, gravel, stone, fertilizer and similar materials.

Electric Hoist Book No. 580 is a catalog equal in size and attractive make-up to that of the loader book. This book has also been developed with the thought that the greatest value to all could be obtained only by incorporating constructive material and operation data. Considerably over 100 illustrations were used in the 40 pages.

Metallic Construction for the Modern Home is the title of a handsomely printed booklet, 8½ x 11 in., calling attention in an interesting way to Milcor expansion corner bead, door and window casings, net mesh lath for curves, concealed picture molding and other products of the Milwaukee Corrugating Co., Milwaukee, Wisc. The booklet includes also a special insert setting forth the special values of Milcor Spanish metal tile.

Little Joe is a power attachment for a Ford, described in a circular issued by the Jones Manufacturing Co., Jackson, Mich. It is said it can be put on and detached in one minute and can be carried under the back seat. It turns the Ford into a power plant and while it is especially brought to the attention of farmers for threshing, sawing wood, pumping water, grinding feed, filling silos, it has quite likely emergency uses for the contractor.

Readymade details for built in fixtures are shown on special sheets furnished in an *Architect's Handbook* by the Built-In Fixture Co., 2608 San Pablo Ave., Berkeley, Calif. These details include such things as combination ironing board and table, telephone cabinet, door units, built-in seats and tables, kitchen assembly units and other matter along this line.

Let the Traffic Through in Half the Time is the title of a broadside put out by the Dow Chemical Co., Midland, Mich., showing the economy of curing road jobs with Dowflake calcium chloride.

Editors' Ready Reference Book on the Concrete Industry and Concrete, is a new publication, 6 x 9 in., 40 pages in color, issued by the Portland Cement Association, containing a great deal of reference data on the subject of cement and concrete. The booklet was designed primarily for the use of editors, to give them authoritative facts and figures about the important uses of concrete and the history of the cement industry.

An interesting bulletin inviting the inspection of their new headquarters at Stevenson and Locust Streets, Pittsburg, Pa., has been issued by the Pittsburg Testing Laboratory. There is a picture of the new building, and a description of it calling attention to the lighting and ventilation.

A Price List of Ceresit Waterproofing Products has been issued by the Ceresit Waterproofing Corporation, Otis Building, Chicago, Ill., which consolidates the interests of the Ceresit Waterproofing Co. and the Ceresit Sales & Mfg. Co. This organization manufactures Ceresit waterproofing compound, a plastic paste for waterproofing concrete, cement plaster and cement stucco, and all of the waterproofing and dampproofing products formerly made by both companies.

Literature issued by the Master Builders Co., Cleveland, Ohio, directs attention to a three-purpose compound, Master Mix, intended as a waterproofer to increase the density of the mortar or concrete, preventing absorption and eliminating efflorescence; to add hardening properties, for wear resistance; and as an accelerator to speed up the hardening in cold weather. It is claimed by the producer that Master Mix used in proper proportions will prevent mortar from freezing down to 15° F. Master Mix is a liquid, and is used 1 part to 20 parts of gauging water at temperatures of 32° F. and above; from 20° F. to 30° F., 1 part Master Mix to 10 parts gauging water; and from 15° to 20° F., 2 parts of Master Mix to 10 parts of water.

The Drain Block Co., 926 Main St., Lafayette, Indiana, issues a circular describing *concrete drain block* which when laid as the first course in the construction of a basement wall provides for carrying away water. With this construction the footing in the arch of the drain block provides the drainage, the floor level being 1½ in. higher than the footing, thus making a sealed joint at this point.

Literature describing *Twindolox* has been issued by the Mills-Penfield Corp., 154 Nassau St., New York. Twindolox is a window lock that is automatic and said to be Jimmy-proof, forget-proof and yet easily operated. It locks the window at any level; operates the upper sash through the operation of the lower one so that the window cannot be closed unless locked first. The device is said to be very easily installed and operated.

The Maroa brick cleaning machine, model No. 3 is the subject matter of a circular issued by the Maroa Manufacturing Co., Maroa, Ill. The machine, power operated, is designed to clean the mortar off used brick. A number of cutters are operated at the speed of an ordinary drill. They rotate in opposite directions, being operated by intermeshing steel cut gears. The manufacturers say the machine will not break the brick, that the softest brick may be cleaned with the device, and that the saving alone on broken brick will average $4.00 a day over hand methods on the quantity cleaned.

Novocrete is the subject matter of a little pamphlet issued by the Novocrete Co., 522 Fifth Avenue, New York City, describing the uses and recording tests of a new material, made with portland cement and mineralized sawdust as an aggregate, instead of using sand and gravel. Literature describes it as of low cost, considerable strength, two-thirds the weight of ordinary concrete, with good insulating value, fireproof, showing good wear resistance. The pamphlet reports tests made by the Department of Engineering at Columbia University showing standard briquets of Novocrete having a tensile strength of 243 lbs. per sq. in. at 7 days and a compressive strength of 1030 lbs. at 7 days. Tests to determine the wearing value of the material were made on samples 28 days old and four months old with a Dorry hardness machine. These tests show wear value better than samples of concrete tested; the material also passes fire tests satisfactorily.

Donley Book of Fireplaces is an attractive 6x9-in. publication describing and illustrating fireplace designs for the architectural effects and explaining in detail, with drawings, fireplace construction from the standpoint of efficiency, in addition to illustrations and descriptions of Donley fireplace specialties, including dampers, fire baskets, ash dumps, etc.

Ambi Concrete Roofing Tile is the subject matter of a circular issued by the American Ambi Corp., 345 Madison Ave., New York City, illustrating and describing concrete roofing tile machines of Ambi make, for producing concrete roof tile of French, Spanish, double-interlocking and double shingle types.

The Finishing Touch is issued every now and then by the Abram Cement Tool Co., Detroit, Michigan, "in the interests of builders for permanence." It features trowels and other tools and emphasizes most of all the Abram long-handled, double-action finishing tools for which the slogan is, "they put a man on his feet."

Beautiful and Permanent Walls and Ceilings are the Body of Architectural Excellence. This is a very attractively printed piece of trade literature issued by the Truscon Steel Co., describing and illustrating in detail the hows and whys and the results of the use of metal lath on interiors to avoid cracks and undue fire hazards.

A new Spanish roof tile machine of the Crawfordsville Foundry Co., Indianapolis, Ind., is the subject matter of a new circular issued by the company for making concrete tile of Spanish pattern. The tile weigh 4½ lb. each and run 650 lbs. to the roofing square. Two nail holes are punched through the tile while on the pallet and tile are still in the machine, although only one nail is used to fasten each tile to the roof. Cleats on the top sides of the pallets are a feature of this design of tile, as well as other tile made on Crawfordsville machines. These prevent the thin layer of concrete from slipping while being tamped and trowelled and adds speed to production. The circular shows a number of the specials which go with the roof tile, for which molds are provided.

White Trucks for Lowest Cost Hauling of Building Materials—a 30 page publication 8½ x 11 in., issued by the White Co., Cleveland, Ohio, illustrating and describing the use of White trucks in the solution of hauling problems in the building supply business in various parts of the country, small cities and large.

They Weather all Weather is the title of a 24-page and cover booklet issued by the Barber Asphalt Co., Philadelphia, Pa., describing the Genasco Latite Shingles. The booklet describes and illustrates the composition of the shingles, their various shapes, styles, and colors, and gives attractive examples of the use of Genasco shingles and explicit directions as to how they should be put on the roof.